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Svante Elis Stromgren
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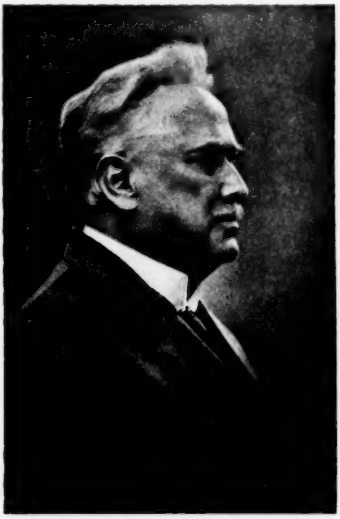
By JULIE M. VINTER HANSEN

On April 5 Professor Elis Strömgren of Copenhagen died suddenly in a hospital from coronary occlusion.

A native of Sweden Elis Strömgren studied astronomy at the University of Lund and in 1898 passed his doctor's degree at that seat of learning to which he became attached as Docent. The years 1901-07 he spent in the German University town of Kiel assisting the editor of the venerable journal *Astronomische Nachrichten* and from 1904 also teaching astronomy at the University. Finally, in 1907, he became Professor of Astronomy at the University of Copenhagen and Director of the Observatory in that city which offices he held until the age of retirement in 1940.



SVANTE ELIS STRÖMGREN
1870-1947

Strömgren's scientific work was all in the field of Celestial Mechanics. His main researches deal with the original orbits of comets and with

the problem of three bodies, particularly the so-called "restricted problem" (Problème restreint). As regards the comets he was especially interested in those with near-parabolic motion and for a number of such comets with eccentricities just below or above 1 he examined the orbits so far back in time that the perturbations from the major planets became insignificant, and he was able to show that in practically all cases the orbital elements had changed in a more elliptic direction. Thus it would appear that all known comets so far belong to our own solar system which result of course does not preclude the possibility that some day we may be visited by a comet from interstellar space.

"Problème restreint" has attracted many outstanding mathematicians, as for instance Poincaré who treated it as a problem of perturbations with one predominant body and one smaller body which perturbed the motion of the third, infinitesimally small mass, while T. N. Thiele and G. H. Darwin dealt with the problem from the supposition that the two main bodies were of the same order. Strömgren continued his predecessor Thiele's researches but on a much larger scale, and, assisted by a number of pupils, he solved, through an enormous computational work of numerical integration, the problem of finding all existing classes of simple-periodic solutions specified by their relation to the two main masses and the five points of libration, introduced by Lagrange. Also for each class were followed, from beginning to end, the various forms of the orbits changing with the initial distance of the starting point on one of the axes of the small mass from the afore-mentioned seven points and it was shown that every class has a natural termination (*e.g.*, infinity or an asymptotic orbit). The results are all published in the publications of the Copenhagen Observatory.

Elis Strömgren had a fine style of writing. Together with his son, Bengt Strömgren, he published an excellent handbook of astronomy for use at the Copenhagen University. An enlarged edition of this work has appeared in German as "Lehrbuch der Astronomie" (1933). Several small popular books on astronomy as also his activities, for 27 years, as chief editor of the popular inter-Scandinavian journal *Nordisk Astronomisk Tidsskrift* bear witness of his power of explaining even quite difficult problems in an easily understandable and yet exact form.

Strömgren was a member of various scientific academies and he was a well-known figure in international astronomical life, in which he took a great interest. From 1921-30 he was president of the "Astronomische Gesellschaft" and as a member of several commissions under the International Astronomical Union he was also very active. His sincere feeling of the importance of international intercourse was put to the test by the two world wars. In 1914 only one bureau for astronomical telegrams existed, with its seat in Kiel. At the outbreak of the first war the danger was imminent that all astronomical news service might come

to a stop. Elis Strömgren, however, immediately started an emergency bureau in Copenhagen and succeeded all through the war in distributing astronomical news, by telegrams and circulars, all over the world. After the war the Allies for a short while had their own bureau in Brussels, but in 1922 this bureau which is one of the activities of the International Astronomical Union was moved to Copenhagen with Elis Strömgren as its director and has been there ever since. Even in the second world war, during the German occupation of Denmark, Professor Strömgren was successful in keeping the news service going. It was an immense satisfaction and pleasure to him that Copenhagen formed the frame around the first Council meeting of the Union after that global catastrophe that had disrupted so many international co-operative activities.

Elis Strömgren was married to the highly gifted Hedvig Lidforss of a well-known Swedish academic family. Mrs. Strömgren is a dentist by profession and a prominent writer of the history of dentistry. In this academic home under the old trees of the observatory, so often visited by foreign scientists, two sons grew up, Bengt, his father's successor, and Erik, now Professor of Psychiatry at the University of Aarhus and Head of the Asylum at that city. It was without any doubt one of the greatest joys in Elis Strömgren's life that his elder son Bengt took up astronomy and became his successor. Even after his retirement and up to the very last days of his life he was in daily contact and held consultations with his son on problems of astronomy.

COPENHAGEN OBSERVATORY, JUNE, 1947.

Tycho Brahe*

By BENGT STROMGREN

The following account of the activities of a person whose name is permanently and inseparably connected with the early stages of the development of Astronomy, by one whose life and experience are so intimately associated with the geographical setting of those activities, possesses unusual interest for all who have made a study of this science.

Although delivered in Danish, we are, through the courtesy of the author, printing the address here in English. We consider ourselves very fortunate in being able to do so. EDITOR.

"The restoration of astronomy was first conceived and determined by that Phænix of astronomers, Tycho, in the year 1564." With these words Kepler characterized Tycho Brahe's contribution to astronomy.

*Address given at the Copenhagen University on December 14, 1946, in commemoration of the Fourth Centenary of the birth of Tycho Brahe.

Bessel called Tycho Brahe a king among astronomers, and our generation, too, remembers Tycho Brahe as one of the great pioneers in the natural sciences.

Few Danes have reached a fame comparable to that of Tycho Brahe, and the historic events in his life make a strong appeal to the imagination. He is remembered as the nobleman who broke with his family's traditions and devoted his life to the study of astronomy; who travelled in foreign lands and won fame in the learned world of his time; who as the great scientist built his own spiritual kingdom on an island in the Sound, generously supported by the ruler of Denmark; and who finally, as the proud and hot-tempered vassal quarrelled with his king, left his country, became Imperial astronomer in Bohemia, died and was buried far from his native land.

The scientific life-work of Tycho Brahe brought about a revival of astronomy and made possible that splendid development of this science in the 17th century that was to affect profoundly all spheres of intellectual life.

Tycho Brahe was the first scientist who clearly saw the importance of precise, systematic, and comprehensive observations of natural phenomena. He constructed new astronomical instruments, far more accurate than any that had been made before, and with these he systematically observed the positions of the sun, the moon, the planets, comets, and fixed stars over a period of more than twenty years. From these observations Tycho Brahe himself derived very important conclusions. But of still greater importance was the use that Kepler made of Tycho's observations, when he based the derivation of the laws of planetary motion upon them, those laws that led Newton to the discovery of the law of gravitation.

Tycho Brahe was born four hundred years ago, on the 14th of December, 1546, at the family estate Knudstrup in Scania. Both his father, Otto Brahe, and his mother, Beate Bille, belonged to ancient noble Danish families. Tycho Brahe was the second-eldest child and the eldest son of a family of ten children.

Tycho Brahe grew up at Tostrup in Scania, the castle of Jørgen Brahe, his father's brother. Jørgen Brahe, who was childless, had been promised by his brother that he might educate the eldest son of the latter, as if he were his own son.

We know that Tycho Brahe was taught Latin from his seventh year, and that in 1559, at the age of twelve, he was sent to the University of Copenhagen. In those days it was not uncommon that studies at the University were commenced at such an early age, the education during the first University years being of a rather elementary character. At the time the faculty of Copenhagen University consisted of three professors of theology, one of law, two of medicine, and eight of liberal arts and sciences.

Following the wishes of his uncle, Tycho Brahe in the beginning studied classical rhetoric and philosophy as a preparation for the civil service. Only a short time elapsed, however, before astronomy caught Tycho's interest. This interest was aroused by a solar eclipse which took place on the 21st of August, 1560, and in particular by the fact that astronomers were able to predict celestial phenomena of this kind. Tycho Brahe procured some books in order to study the methods worked out by astronomers for the precalculation of solar eclipses and other phenomena. He came in possession of the principal astronomical work of the time, Ptolemy's Almagest, and began to study it.

Tycho Brahe remained for three years at the University of Copenhagen. He devoted most of his time to mathematics and astronomy, probably contrary to the wishes of his father and his uncle.

It was the custom of those days that young students, who had spent a few years at the Copenhagen University, went abroad and continued their studies at foreign universities. This was in fact an ancient tradition. In the thirteenth and fourteenth centuries a great number of young Danes had studied at Paris, then the most famous among the centers of learning. In the sixteenth century the preference was for the German universities.

In 1562 Tycho Brahe was sent to Leipzig by his uncle. He was accompanied by his tutor, a young man by the name of Anders Vedel, who subsequently distinguished himself as a historian. Tycho's uncle and father still wanted him to prepare himself for the civil services. Tycho however had made up his mind to devote himself to the study of mathematics and the sciences.

In his work "Astronomiae Instauratae Mechanica" (a work of which a translation from Latin into English has been published on the occasion of the quater-centenary) Tycho Brahe has given a description of his studies at Leipzig. Here he says: "After I had already in my fatherland Denmark, with the aid of a few books particularly ephemerides, made myself acquainted with the elements of astronomy, a subject for which I had a natural inclination, now in Leipzig I began to study astronomy more and more. This I did in spite of the fact that my governor, who pleading the wishes of my parents wanted me to study law (which I actually did as far as my age allowed it), did not like it and opposed it. I bought the astronomical books secretly, and read them in secret in order that the governor should not become aware of it. By and by I got accustomed to distinguishing the constellations of the sky, and in the course of a month I learnt to know them all, in so far as they were located in that part of the sky which was visible there. For this purpose I made use of a small celestial globe, not greater than a fist, which I used to take with me in the evening without mentioning it to anybody. I learned this by myself, without any guidance; in fact I never had the benefit of a teacher in astronomy, otherwise I might have

made quicker and better progress in these subjects."

In Leipzig Tycho Brahe divided his interests between observations of celestial phenomena and the study of works on astronomy and mathematics. Gradually he made himself familiar with the astronomical knowledge and tradition of his time. This was built upon the Greek traditions.

During the centuries immediately before and after the beginning of our era, astronomy had been cultivated in Greece, and in other countries under the influence of Greek civilization. Ptolemy's Almagest, which was written in the second century of our era, contains a detailed account of the astronomy of this epoch, its problems, and its methods and results. The principal problem of observational astronomy was the determination of positions in the sky of the fixed stars, the sun, the moon, and the planets, while the chief aim of theoretical astronomy was the development of theories of the motion of sun, moon, and planets relative to the earth made use of a complicated system of composite world the earth was stationary and the moon, the sun, and the planets moved in circles around it. The mathematical description of motion relative to the fixed stars. According to the Ptolemaic system of the circular movements, the system of epicycles.

After Ptolemy there was no great progress in astronomy for more than a thousand years, but the Greek traditions were kept alive, chiefly by the Arabs, and when the interest in the science of astronomy arose again in Europe in the 15th century, it was possible to build on the results of the Greeks. Ptolemy's Almagest, even down to Tycho Brahe's time, remained the Bible of astronomy.

In the 15th and the first half of the 16th century the art of astronomical observation had not developed materially; but in theoretical astronomy a period of immense progress had commenced by Copernicus' announcement (1543) of his heliocentric system of the world. In developing his theories of planetary motion Copernicus built mainly on the observations of the ancients, adding only relatively few of his own. The motion of the earth and the planets relative to the sun were described by means of epicycles.

This was the situation in astronomy when Tycho Brahe began his studies. Within the field of mathematics, algebra, geometry, and trigonometry had reached a considerable development. Physics and chemistry had not yet come into existence as exact sciences. Alchemy attracted considerable interest. Among its aims was the making of gold and of medicaments.

In order to complete the picture it should be emphasized that there was not at the time, after the death of Copernicus, in all Europe a single outstanding astronomer.

Tycho Brahe soon noticed considerable deviations of the positions of the planets as determined by him from observations, from those

given by the existing planetary tables. He resolved to devote his efforts to the task of deriving improved planetary theories and far more accurate planetary tables, and he arrived at the conclusion that this could only be done on the basis of observational material far more extensive than that used by the ancients. In a general way, the attitude of the ancients had been to trust their theories of motion, using only as many observations as were absolutely necessary in order to determine the constants, or elements, of the planetary theories. Tycho Brahe was the first scientist who saw clearly the importance of precise, and as far as possible of continuously extended observations of the positions of the celestial bodies in the sky. Natural as this point of view may appear to later generations, it meant a revolution of human thought, when it was first developed.

Tycho Brahe remained in Leipzig until 1565. Soon after his return to Denmark his uncle Jørgen Brahe died. Tycho's relatives now seem to have yielded to his wish to cultivate the astronomical and mathematical sciences, even though they regarded his interests disapprovingly. The following year, 1566, Tycho went abroad again. The years from 1566 to 1570 may be considered his years of study proper. He spent most of his time in Germany, and returned to Denmark only for brief visits. Tycho Brahe stayed in Wittenberg, Rostock, Basel, and Augsburg. Particularly his stay at Augsburg was of importance to him. He found here a circle of men who shared his interests.

Through this period Tycho made frequent observations of the positions of the celestial bodies. He constructed an instrument for measuring angular distances in the sky, and another, a huge quadrant, for measuring altitudes above the horizon. Both these instruments were marked improvements over the instruments of the ancients.

At Augsburg, Tycho Brahe in 1570 became acquainted with Pierre de la Ramée, Professor of Philosophy and Rhetoric in Paris, and according to J. L. E. Dreyer, Tycho Brahe's eminent biographer, one of the clearest thinkers of the time. Ramée advocated the building up of a new astronomy, a purely inductive science built on the observations with the help of mathematics, but entirely without any hypothesis. Tycho Brahe, although he held that astronomy must be built on extensive observational material, found it necessary to retain the uniform circular motions of the ancients for the representation of the observations. At the time Tycho's was probably the more practical view, but Pierre de la Ramée's ideas foreshadow, if only in principle, Kepler's great work.

In 1570 Tycho Brahe returned to Denmark after having been informed of his father's serious illness. Otto Brahe died soon after, in 1571. The two eldest sons, Tycho and Steen Brahe, inherited Knudstrup, but Tycho during the following years stayed with Steen Bille, his mother's brother, at Herisvad, a former monastery. Of his relatives,

Steen Bille seems to have been the only one who understood his scientific interests.

At Herisvad Tycho Brahe for some years worked chiefly on chemical experiments, until the discovery of a new star again completely turned his interest to astronomy.

On the 11th of November, 1572, Tycho Brahe was on the way from his chemical laboratory to his house, when suddenly he caught sight of a very bright star in the constellation of Cassiopeia which he had never seen before. Already the same evening Tycho Brahe started measurements of the new star, and he continued these during the eighteen months while the star remained visible to the naked eye.

By means of an instrument of his own construction Tycho Brahe measured the angular distances between the new star and a number of the surrounding fixed stars and thus established the position of the former in the sky. The measurements were repeated night after night, and the results showed that the new star, as long as it was visible, remained in the same place of the firmament. From this fact Tycho Brahe concluded that the new star moved neither in the atmosphere nor between the planets, but belonged to the fixed stars. The result necessitated a break with Aristotle's assumption, still maintained at that time, that the world of the fixed stars was unchangeable. Tycho Brahe further made continuous observations of the color and gradually decreasing brightness of the new star.

In 1573 Tycho Brahe published a small book, "De Nova Stella," on the new star. The star had been observed in many other places in Europe, and a number of publications about it appeared. Tycho Brahe's treatise shows that already at that stage he may be considered the most eminent astronomer of the time. It made his name widely known in scientific circles. In 1574 he gave a series of lectures at the University of Copenhagen at the request of the students and the King.

In 1575 Tycho Brahe went abroad once more. Among other places he visited Cassel, Basel, Venice, Augsburg, and Ratisbon, and entered into connection with many of the learned men of the time. Particularly his visit to Cassel, to the Landgrave William the Fourth of Hesse, who was highly interested in astronomy, was of the greatest importance to him.

After his return the same year Tycho Brahe took up his residence at Knudstrup, but it seems that at this time he intended to leave Denmark for ever in order to settle down at Basel. Just then, however, a Danish embassy returned from a visit to the court of the Landgrave William the Fourth of Hesse. Through this the Landgrave earnestly requested King Frederick to enable Tycho Brahe to cultivate the science of astronomy at his wish, in honor of the King and his country and for the benefit of science.

King Frederick the Second, who had formerly displayed a great in-

terest in Tycho Brahe's work, now offered him the island of Hven in the Sound as an entailed estate, together with ample economic support. After having considered the matter for some days, Tycho Brahe accepted the King's offer.

On the 23rd of May, 1576, the King signed a document to the effect that he presented the island of Hven to Tycho Brahe for life as an entailed estate. A few days later 400 daler were paid out to Tycho Brahe for the erection of a building in Hven. Already before that the King had promised Tycho Brahe an annual grant of 500 daler. During the following years Tycho Brahe's income from the crown reached about 2000 daler a year (1 daler at that time had about the same purchasing power as $20 nowadays. The annual income of the State of Denmark in the period in question amounted to somewhat above 200,000 daler). King Frederick the Second thus amply fulfilled his promises to Tycho Brahe.

On the 8th of August, 1576, the foundation stone was laid for the building in Hven which was to serve Tycho Brahe as residence and observatory. Tycho Brahe called the building, or castle, Uraniborg.

The astronomical observations in Hven were begun in December, 1576, and continued without interruption through more than twenty years. To begin with Tycho Brahe had few astronomical instruments, but in the course of the years he constructed one instrument after the other. In 1591 Tycho Brahe sent to the Landgrave William the Fourth of Hesse a description including 28 larger and smaller instruments. As early as 1585 the collection, however, was nearly complete and the methods of measurements mainly worked out.

At first the instruments were erected at Uraniborg, but, as the number of instruments and collaborators increased, a wish for a special observatory building arose. So in 1584 Tycho Brahe built Stjerneborg on a hill about a hundred feet south of the southern end of the Uraniborg grounds. Stjerneborg consisted of subterranean crypts, in which the instruments were mounted. Only the revolving roofs, which were opened when observations were to be made, rose above the ground, so that there was good protection from the wind.

The purpose of Tycho Brahe's observations was that of determining the places of the fixed stars, the sun, the moon, and the planets in the sky, their positions being expressed by angular co-ordinates, in the case of the fixed stars once and for all, in the case of the sun, the moon, and the planets so often that a complete and reliable picture of their courses might be obtained.

Tycho Brahe planned and carried through observations of this kind that were much more accurate and comprehensive, and more systematically arranged than those made previously. In "Astronomiae Instauratae Mechanica" he says: "Meanwhile I also energetically started observing, and for this work I made use of the assistance of several

students who distinguished themselves by talents and a keen vision. I had such students in my house all the time, one class after another, and I taught them this and other sciences. Thus by the grace of God it came about that there was hardly any day or night with clear weather that we did not get a great many, and very accurate, astronomical observations of the fixed stars as well as of all the planets, and also of the comets that appeared during that time, seven of which were carefully observed in the sky from that place. In this way observations were industriously made during 21 years. These I first collected in some big volumes, but later on I divided them up and distributed them among single books, one for each year, and had fair copies made."

Tycho Brahe's astronomical instruments and methods of determining the positions of celestial bodies were similar to those of his predecessors as far as the general principles are concerned. In the details of the constructions and in the quality of the mechanical work, however, there were numerous significant improvements. This, *e.g.*, applies to the arrangement of the sights of the instruments, the divisions of the arcs, and the mounting of some of the instruments.

One of Tycho Brahe's main instruments was the so-called mural quadrant, which was fixed in the plane of the meridian, and served for the measurement of the altitudes of the celestial bodies above the horizon in the south. Revolvable quadrants were available for measuring altitudes outside the meridian, as well as azimuths.

Another type of instrument was the so-called equatorial armillary instrument, which was used for the measurement of angular co-ordinates in relation to the equator of the sky and for those determinations of the time which were necessary for the control of Tycho Brahe's primitive and inaccurate clocks.

A third group of instruments comprised various instruments for the measurement of the angular distance between two celestial bodies. Most important of these was the so-called triangular sextant.

By combination of the measurements made with the various instruments Tycho Brahe could derive the desired positions of the celestial bodies. The declinations were found from altitudes, particularly from meridian altitudes. Differences of the right ascensions of two celestial bodies were determined by the equatorial armillary instruments, or with the help of the sextants. In the latter case the declinations of the two celestial bodies had to be known. Their angular distance was observed with the sextant. The difference in right ascension could then be calculated from the spherical triangle between the two celestial objects and the pole of the equator.

Absolute right ascensions of the sun were derived from meridian altitudes. For the purpose of determining differences in right ascension of the sun and stars, Venus was used as a connecting link. Observations were made of Venus both as a morning star and as an evening

star in order to eliminate the effects of refraction.

Tycho Brahe made extensive series of observations for the purpose of determining the refraction as a function of the altitude. In this connection it must be remembered, however, that Tycho Brahe adopted Ptolemy's value of the solar parallax, 3′. This introduced corresponding errors in his refraction tables, and led to the adoption of different values of the refraction for the sun and for the stars.

Altogether the result of Tycho Brahe's efforts was that his observations of the positions of the celestial bodies were about ten times as accurate as those of his predecessors. While the determinations of position of antiquity showed errors of observation averaging nearly 10 minutes of arc, *i.e.*, one third of the diameter of the moon, the average error of observations with Tycho Brahe's best instruments was less than one minute of arc.

During the years 1576-1597 determinations of the positions of more than 1000 fixed stars were made at Hven (among them particularly accurate observations for 777 fixed stars) ; further, an unbroken series of observations of the sun, the moon, and the planets was obtained. This material of observations by its accuracy and extent surpassed anything that had previously been achieved in astronomy, indeed in all science.

Seven comets, which made their appearance in the sky during the period mentioned, were also observed accurately. From the observations in question Tycho Brahe drew the new and important conclusion, that the comets were celestial bodies moving in space between the planets and were not atmospheric phenomena. From the observations of the comets Tycho Brahe further concluded that the solid crystal spheres of the ancients did not exist, as they would not have allowed the comets to follow the orbits actually observed.

From the very beginning Tycho had intended to utilize the observations of the sun, the moon, and the planets for the deduction of theories of movement for these celestial bodies, theories which were to agree with the observations, and which might be used for a precalculation of the courses of the planets among the fixed stars. In other words, Tycho Brahe wanted to tackle the same problem as that on which Ptolemy and Copernicus had been working, but he aimed at obtaining more accurate results on the basis of better and more detailed observations.

Tycho Brahe admired Copernicus, but he did not accept his heliocentric system. Instead, he devised his own system, the Tychonian system of the world. According to this the earth is stationary in the centre of the system. It is circled by the moon and the sun, whereas the planets circle around the sun as in the Copernican system. The relative movements of the celestial bodies here are the same as in the Copernican system but the earth does not move.

One of the reasons why Tycho Brahe rejected the Copernican system, was that he had been unable to observe the annual movements of the courses of the fixed stars, which are a consequence of Copernican theory of the movement of the earth round the sun. Copernicus had avoided contradiction with observation by assuming very great distances to the fixed stars, but Tycho Brahe, on the basis of observations of the angular diameters of the fixed stars thought himself justified in concluding that the Copernican distances of the stars involved unreasonably great linear dimensions for the fixed stars. It only became evident, after the introduction of the telescope into astronomy, that the angular diameters of the fixed stars are much smaller than the values assumed by Tycho Brahe, and only then did Tycho Brahe's objection lose its importance. With the invention of the telescope, with Kepler's, Galileo's, and Newton's work in the 17th century came the final decision in favor of the Copernican system.

On the basis of his solar observations Tycho Brahe set up a theory of the relative movements of the sun and the earth which allowed of considerably more accurate precalculations of the position of the sun than any previous one.

Tycho Brahe's investigations of the movements of the moon became of even greater importance. His observations of the moon were not only much more accurate than those of former times, but also, in contrast to these, evenly distributed along the whole course of the moon. They resulted in the discovery of new periodical inequalities in the motion of the moon and hence in more accurate precalculations of the position of the moon. Although Tycho Brahe did not himself succeed in finishing these investigations, they marked the beginning of a development which was later continued in the systematic lunar observations of the Greenwich Observatory and in Tobias Mayer's lunar theory from the middle of the 18th century, a development which was to have very important practical consequences, as it enabled determinations of the geographical longitude at sea by lunar observations.

Tycho Brahe attempted the development of the theory of motion of the planets according to the principles of Ptolemy, but his attempts were only partly successful. It fell to Kepler, after Tycho Brahe's death, to turn his observations of the planets to full account.

Tycho Brahe was a pioneer within the sphere of geodesy and cartography. With his instruments he measured the angles of a great many triangles formed by elevated points round the Sound in Hven, Sealand, and Scania. At Uraniborg he made a basis measurement, and azimuth observations. Tycho Brahe thus carried out the first triangulation known.

The triangulation method, which is used in our time in all measurements of the earth, and the results of which form the basis of all cartography, thus was worked out and first used by Tycho Brahe. Formerly

the introduction of this method has been ascribed to Snellius the Dutchman; but there can be no doubt that it is due to Tycho Brahe. Tycho Brahe published a map of Hven, and according to N. E. Nørlund, who has brought to light Tycho Brahe's contributions within the sphere of geodesy, this is the earliest map of any part of the Scandinavian countries based on a geodetic survey.

As was mentioned above, Tycho Brahe in his youth shared the interest of his time in astrology. In his first lecture at the University of Copenhagen in 1574 he gives an account of his view of the possibility of drawing conclusions as to human fate from the positions and courses of the celestial bodies. Tycho Brahe here tries to invalidate a number of objections to astrology and at that time seems to have considered astrology as a science with profound contents of truth. In the course of time, however, Tycho Brahe got more and more skeptical. In a letter dating from 1587 he writes, on account of a question concerning an astrological problem, that he will answer it, "although I prefer not to discuss problems of astrology, which deals with the question which significations and prophecies can be deduced from the starry sky, because one cannot build much upon it, but I have only, for many years, endeavored to put astronomy in rightful order, astronomy, which investigates the wonderful courses of the celestial bodies; for through the latter science it is possible by means of well-constructed instruments and on the basis of the sure principles of geometry and algebra with laborious industry and work to find the truth proper."

As late as the 17th century astrology was still cultivated by scientists. Only after the progress of astronomy by Kepler's, Galileo's, and Newton's contributions did astrology disappear for good from the horizon of science.

In the course of time Tycho Brahe in Hven created his own scientific realm. He got numerous pupils and assistants, both Danes and foreigners, who for a short or prolonged time stayed in Hven. He invited architects and artists, and, for the making of his instruments, able craftsmen. He founded a paper-mill and had his own printing-house and bookbinder's shop, where his astronomical works were produced to be sent all over Europe.

Tycho Brahe's fame was growing, and he became a leading figure in the cultural life of his time. He had numerous visits from prominent persons. The King of Scotland and in 1592 Prince Christian, the later King Christian the Fourth, who was still under age, inspected Tycho Brahe's buildings and instruments in Hven.

Frederick the Second until his death in 1588 continued giving Tycho Brahe all possible support. Tycho Brahe paid back by the lustre his work lent to Denmark. As a lord-lieutenant he caused certain difficulties to the King. He wronged his peasants and he did not fulfill all of his obligations (attending to lights, etc.) which he had taken upon him-

self in return for some of the economic privileges he enjoyed. Frederick the Second, however, remained lenient.

The regency which governed Denmark after the death of King Frederick the Second in 1588, until Christian the Fourth was declared of age and was crowned in 1596, supported Tycho Brahe as liberally as Frederick the Second had done it. Particularly Niels Kaas and Jørgen Rosenkrands were powerful and sympathetic friends of Tycho Brahe.

Niels Kaas died in 1594 and Jørgen Rosenkrands in 1596. King Christian the Fourth and his advisers had different views of Tycho Brahe from those of the former regents. The special grace, which had secured extraordinary favors for Tycho Brahe, in spite of acts and remarks of Tycho Brahe's which must have had an offensive effect, was no longer present.

In 1596 and 1597 the King and the government deprived Tycho Brahe of most of his economic privileges. He did keep Hven as an entailed estate and his financial position was excellent, even though perhaps it might not allow him to continue his work in Hven as before.

Tycho Brahe, however, made up his mind to leave Hven in March of 1597. After a short stay in Copenhagen he left Denmark in June the same year and took up his residence first at Rostock and then at Wandsbeck in Holstein, as the guest of Henrik Rantzau, the governor.

It seems as if Tycho Brahe, immediately before he left Hven and Denmark, felt his position threatened by the government through commissions wanting to inquire into his relations to the peasants in Hven and complaints of Tycho Brahe's chaplain in Hven. The main reason for Tycho Brahe's decision to go away, however, no doubt was that he hoped by this means to produce a request on the part of the King that he should return on improved conditions.

In this hope Tycho Brahe was disappointed. He wrote to King Christian from Rostock and in October, 1597, received the King's answer. From this it appeared that Tycho Brahe's conduct had caused a break with the King, and that there was no prospect that Tycho Brahe would be called back. On the other hand Tycho Brahe's pride prohibited him to return and offer his service to the King as the latter invited him to do.

In 1598 the Emperor Rudolph the Second invited the famous Tycho Brahe to take up his residence in Prague. He promised him a similar support as the one he had enjoyed in Hven. Tycho Brahe accepted the invitation and in 1598 settled in Bohemia, from 1600 at Prague. Rudolph the Second was keenly interested in Tycho Brahe's works, but had great difficulties in redeeming his economic promises to him. Gradually, however, Tycho Brahe succeeded in having moved and mounted his instruments and by the aid of assistants in resuming his astronomical observations and calculations.

Tycho Brahe's health, however, had been sapped. He died at Prague

on the 24th of October, 1601, at the age of 54. He was buried amid great honors in the Teyn Church at Prague.

The years 1597-1601, which Tycho Brahe spent in exile, had not been so fertile with regard to scientific work as the previous years in Hven. The stay in Bohemia, however, carried with it one thing which was to be of decisive importance to the future development of astronomy, for Tycho Brahe here met Johannes Kepler and entered into scientific collaboration with him. After Tycho Brahe's death Kepler worked up his observations of the planets. On the basis of these he found the famous Kepler laws of the motions of the earth and the planets round the sun, the laws which toward the end of the 17th century led Isaac Newton to his discovery of the law of gravitation.

Uraniborg and Stjerneborg, Tycho Brahe's observatories in Hven, were destroyed in the course of a few decades after his death. His instruments were destroyed during the war in Bohemia in 1619.

It may justly be said that Tycho Brahe was the greatest scientist of his time. His observational work, as the foundation upon which Kepler and Newton built, profoundly influenced the development of astronomy in the following centuries.

Not long after Tycho Brahe's death the telescope was introduced into observational astronomy by Galileo. The introduction of the telescope, the pendulum clock, and the microscope led to the development of new methods in positional astronomy, but the general aims have remained similar to those formulated by Tycho Brahe. The accuracy of the observations has increased more than a hundredfold, the number of celestial objects observed is vastly larger, the fixed stars are considered fixed no longer, and the field of application of the determined positions has increased enormously; yet the aim of positional astronomy is still that precise and complete record of the places of the stars and their changes in time, the establishment of which Tycho Brahe was the first to attempt.

The introduction of the telescope widened the field of astrophysics enormously. Now a whole new world was opening up to observers. The ancients, and Tycho Brahe, too, had had to be content with estimates of the brightness and color of celestial objects. Still, when quite recently the nature of Nova Cassiopeiae 1572 was made the subject of an astrophysical investigation, Brahe's systematic series of comparisons of the brightness of the Nova with those of other stars proved to be of decisive value. The true nature of the Nova, a Supernova of type I, was established; and we may imagine that when in future work on this Nova the 200-inch telescope at Mt. Palomar will be turned in the direction of the possible remnant star, this giant of modern astronomy will be set by the position Brahe measured in 1572, and that the accuracy of his position will increase chances of success, literally, a hundredfold.

Tycho Brahe in his writings calls himself Tycho Brahe Danus, Tycho

Brahe the Dane, and Denmark is proud of its great son. But Tycho also says that an astronomer must be a citizen of the world. Today we feel, perhaps stronger than ever, that scientists of different centuries, and different nations, are united by common endeavor.

A Tycho Brahe Statue on Hven
(Courtesy of Miss Julie M. Vinter Hansen)

On August 25, 1946, a Tycho Brahe monument was unveiled, by the Swedish Crownprince, on the island of Hven, the former site of the two famous observatories "Uraniborg" and "Stjerneborg." Talks evaluating Tycho's scientific achievements were given by Professor E. Strömgren, Copenhagen, and Professor K. Lundmark, Lund. The statue is the work of the Swedish sculptor Ivar Johnsson and is of light grey granite and rather unorthodox in its composition. It is placed in the grounds that once formed the garden of "Uraniborg," and Tycho, in the garb of his times, is shown facing the site of this castle but he is looking at the sky with a small measuring instrument in his left hand. The setting of the statue at this sacred spot of astronomy, framed by the fertile, smiling fields of Hven and the blue Sound, is very picturesque.

Sir Isaac Newton

By JAMES LANGHAM

"Nature and Nature's laws lay hid in night;
God said, Let Newton be—and all was light."

With these words Alexander Pope paid one of the finest of all tributes to the memory of Sir Isaac Newton, philosopher, physicist, mathematician; words which have been inscribed in stone over a fireplace

in an old greystone Manor House at Woolsthorpe-by-Colsterworth near Grantham in Lincolnshire.

Here, in this room, in a remote part of the English country-side, in the year 1642, was born a man who was to have perhaps the unique privilege of being called a genius by his contemporaries.

In his early years, spent at Woolsthorpe, there was, however, little indication of the great intellectual strides which Isaac Newton was to make later; and in the first part of his life at the King's School, Grantham, where he was sent at the age of twelve, he appears to have been a "healthy, normal, and by no means perfect boy." One example of this may be seen in the carving of his name on one of the window-ledges in the old school.

He was living at this time, during school term, with an apothecary named Clarke, the brother of his mathematical master, and here we find the first indication of the way his mind was working. He began to make mechanical models. At nine, he had carved with his penknife a sundial out of a block of stone. He made a water-color clock out of a box, and this was used by the Clarke family long after Isaac had left Grantham. He made a model of a windmill and tried to develop the idea of driving it by animal power, and he used to catch mice to place inside it. Another of his "inventions" was a paper lantern. During the winter months he would take it to school and sometimes he would attach the tail of a kite to it to frighten the superstitious.

There was some slight risk that at fifteen Isaac Newton might be persuaded to accept the traditions of his father's family and become a farmer; but his mother's foresight prevailed. His love for mechanical and mathematical problems was accepted. And so he went to Trinity College, Cambridge, at the age of eighteen.

This was in 1661, and his first years at Cambridge as an undergraduate were memorable for his remarkable understanding of the fundamentals of mathematics. Four years later he left the University on account of the Plague, and it was while he was staying at his home at Woolsthorpe that he made his first important contribution to science. Needing a "calculating tool," he had already invented the "Binomial Theorem," and by a modification of this he invented a system of "fluxions"—to find the tangent and radius of curvature at any point of the curve—and now, wanting to calculate the shapes of bodies of least resistance, he invented what is known as the "Calculus of Variations." In 1667, he returned to Cambridge and became a fellow of his college.

His work there will be remembered for all time and among the many portraits and statues of Newton that have survived there is perhaps none more fitting then the statue of Roubiliac in the Ante-Chapel at Trinity College, with the inscription:

"Newton qui genus humanum ingenio superavit."

But what was Isaac Newton like as a man? There is much supposi-

tion, little factual evidence. Biographers are often diffident in their approach when a seventeenth century character is to be ticketed and docketed as a human being rather than as an "artist" or "scientist" or professional person. It may, however, be taken for granted that Isaac Newton, country-born and country-lover, was in the first place a man of considerable humility. Obviously, from all obtainable evidence, he was shy, indifferent to praise, interested fundamentally only in the eternal truths. He himself once wrote: "I see not what there is desirable in public esteem, were I able to acquire and maintain it: it would perhaps increase my acquaintance, the thing which I chiefly study to decline."

He was imaginative in the sense that any great man must be imaginative. "The scientific use of the imagination" was obviously part of his greatness; but he was not interested, imaginatively, in the fine arts as we know them. There were no books of poetry on his shelves, no works of art upon his walls; and his only interest in music appears to have been a book on the vibrations of musical strings.

When he was forty-five, Newton published his "Principia" which has been described as the greatest work on exact science that the human mind has ever conceived. It originated in the year 1666 when Newton took up the question of gravitation. It has been related that as Newton "sat alone in his garden (at Woolsthorpe) he fell into a speculation of the power of gravity" which he then already connected with the lunar and planetary motions. Voltaire added to the account the well-known incident of the falling apple that is said to have started in Newton's mind the train of thought extending the force of gravitation beyond the apple into space and to the moon and the heavenly bodies. Newton, then, was the first to prove, mathematically, the universal law of gravitation.

But there were many other discoveries of the highest importance to science for which Newton was responsible. Among the greatest of these was his work on Optics. His earliest printed works, in fact, concerned optical researches. They were published in the Philosophical Transactions of the Royal Society when Newton was about thirty years old. The first publication was the most important. It gave the result of his experiments with the glass prism and contained the important discovery, only remotely guessed at before Newton's time, that solar light consists of seven primary colors.

It is not always realized that Newton was also a very fine mechanic. For instance, he ground and polished lenses; and, as a metal worker, he made a reflecting telescope which can be seen in the library of the Royal Society. In the same library is a chair known as "Newton's Chair." It is probable, though not certain, that this also is Newton's work. We are told that "the joinery is distinctly good, but the design rather faulty."

Newton became Lucasian Professor during his Cambridge career and it seems to be clear that he retained his professorship and also his fellowship when he was appointed Warden of the Mint. This was in 1696. Three years later he became Master of the Mint, an appointment which he held for twenty-eight years. A comfortable income was therefore assured and Newton was in the position of being able to carry out his experiments without financial worry.

He was living in London during the latter part of his life, and researches enable one to estimate with some accuracy the kind of home life which Sir Isaac enjoyed. To understand it one must understand first and foremost that he was a man of great simplicity with few worldly ambitions, few desires common to other men.

Let us go, then, in imagination to the seventeenth-century Kensington home of a scientist whose interests are far removed from the homely things that most of us grow to love. One might suppose that the Master of the Mint and President of the Royal Society might care to possess some beautiful furniture or other signs of luxury. But no. In Sir Isaac's bedroom, for example, there is neither cupboard nor chest of drawers, nor even an oak case. Jugs and basins in bedrooms of the period were not uncommon. Yet in Newton's room there appears to be only "four pails and washing tubs." There is also only one pair of silver candlesticks, the others being of brass. Newton kept only one manservant in the house and he slept in the hall on a "settle bedstead."

Incidentally, there is an interesting sidelight on Newton's taste. Evidently he was very fond of the color red, for much in his house is referred to in his famous "inventary" as crimson. Nearly everywhere there were crimson curtains. His bed was of "crimson mohair," and "all the beds in the house had calico quilts made of red cotton printed with Cashmere patterns." And in his dining-room there was a "crimson settee."

It is evident, at any rate, that Newton was not a "collector." Not only does our inspection of the house prove it, but he himself, speaking of Lord Pembroke, once said: "Let him have but a stone doll and he is satisfied. I can't imagine the utility of such studies: all their pursuits are below nature."

Some relaxation was necessary, and we are told that Sir Isaac's favorite recreation at home was Backgammon, and one biographer's description of the imaginary scene is worth quoting: "We can picture to ourselves the friend going to call on Newton in the early morning, being shown into his bedroom, their adjourning to 'The Closet' (Newton, possibly in his 'double night cap') and sitting at the card-table playing backgammon whilst drinking chocolate. We may even imagine, later, the barber arriving to shave Newton, Newton reclining on the 'crimson settee' for that purpose. Mrs. Conduitt, his niece, comes into the room in order to tell 'Uncle Isaac' what clothes he is to wear, re-

minding him that the King is going to the Mint and that he must not forget to put on his sword. The manservant brings up his master's well brushed and combed wig on its 'perruque stand,' and Newton, selecting one of his two sticks, enters his sedan-chair. He starts on his way to the Mint. Probably he goes by river from a spot near Charing Cross."

Artists of the past have bequeathed to us a number of portraits and pieces of sculpture, each of which seems to convey an individual aspect of one of the greatest scientists who ever lived. Prominent among them is Roubiliac's statue in Trinity, mentioned earlier, an engraving after Vanderbank in the Grantham museum, and Gandy's portrait painted in 1706. This is perhaps the most compelling of all. It shows Sir Isaac in the prime of life, without a wig, an expression of determination and kindliness on his face. And there are portraits by Sir Godfrey Kneller, Sir James Thornhill, and many others.

Sir Isaac Newton was eighty-five years old when he died in March, 1727. His tomb in Westminster Abbey is one of the most magnificent monuments of which the Abbey may boast.

On March the twenty-eighth of that year his body, after lying in state in the Jerusalem Chamber where it had been brought from his death-bed in Kensington, was buried at a certain place in front of the Choir. It was said to be: "one of the most conspicuous in the Abbey, and had been previously refused to various noblemen who had applied for it." Voltaire was present at the funeral which was also attended by the leading members of the Royal Society.

To condense in a brief sketch all that Newton was, all that Newton stood for, is a task that few men, if any, would be qualified to undertake. But here and there we find, if not the answer, at least the indication of the man's greatness.

It was Dr. Johnson, speaking of Newton's superiority of mind, who said: "He was able to separate knowledge from those weaknesses by which knowledge is disgraced; and he was able to excel in Science and Wisdom, without purchasing them by the neglect of little things. He stood alone merely because he left the rest of mankind behind him, not because he deviated from the beaten track."

And another writer, as able in his analysis, has said: "That man is well on the way to being a genius who can take a second man's subject, apply it to a third man's method, and get more out of either than the originators. How then shall we estimate the intellect of Newton, who, finding comparatively flimsy foundations, digs them out, goes down to bed-rock and erects a noble edifice, beautiful within and without—an imperishable proof of unparalleled genius."

Ejnar Hertzsprung and the Leiden Observatory

(Communicated by Dr. K. AA. STRAND)

On the 25th of June, 1946, a small group of students and friends gathered at the Observatory in Leiden to say farewell to Professor Hertzsprung, who after retirement as director of the Leiden Observatory returned to his native country, Denmark.

On this occasion Dr. Oort made the following speech, which he has been kind enough to allow to be translated for publication in POPULAR ASTRONOMY.

"There is no astronomer in the world for whom I have more admiration than for you, Professor Hertzsprung. You stand as a bright figure in the line of great astronomers. Your work has laid the foundation for a new astronomy. In your work and in your person there is much which makes me draw a parallel between you and your Danish predecessor, Tycho Brahe. The similarity lies not only in the fact that you did an important part of your scientific work outside of your native country, but above all in the task that you have set yourself—accurate observations.

"Just as your great countryman, you were convinced that first of all the progress of astronomy requires accurate observations. From this conviction grew your scientific program. With the same perseverence and with the same enormous energy as Tycho you have devoted your whole life to it; you have sacrificed everything else. The complete subordination of yourself and the complete surrender to this ideal should remain as an inspiring example to everyone who has worked with you.

"I do not know whether your observations will bring about as important a change in astronomy as those made by Tycho Brahe. Even if their influence should be less revolutionary I am convinced that for several coming generations your work will form a basis upon which they can rely more than upon any other source within this period. Your attitude towards your colleagues and collaborators showed two clear features: great reserve and straightforward criticism. Naturally, this attitude was now and then unpleasant for others, but no one could complain that your criticism was not sound, and it was a consolation to everyone that you reserved the strongest criticism for your own work.

"Everything you have done carries the seal of your personality which means the seal of high quality. If in discussions of others we may sometimes doubt whether what they discuss is real—or, whether, as you put it, they are seeing ghosts; with you we know everything has been so critically reviewed that one can build a house on it, or, in your own words 'swear to it.'

"When the great theoretician Eddington needed data he obtained

them, whenever possible, from Hertzsprung.

"The work of astronomers differs from that of other scientists in that the time element constitutes a very important part. Up to a certain point it makes no difference to the physicist and the chemist whether an observation is made now or later; for many astronomical phenomena, on the other hand, it is of great importance that they be observed now and with the greatest accuracy. You, Professor Hertzsprung, have keenly kept in mind from the beginning of your astronomical career that the greatest benefit to astronomy lies in making observations with the greatest accuracy that is obtainable at the moment. Who would blame you when your curiosity sometimes made you spend a while on the discussion of preliminary results? To such a deviation from your life program we are indebted for the list of extremely accurate proper motions of the Pleiades, which, as your last very substantial contribution, will appear in one of the next parts of the Annals of the Leiden Observatory.

"Your work is marked moreover by an exceptional modesty. You have always felt and also preached that the astronomer cannot know beforehand what will be important and what not, but that it is important to observe in an intelligent way that which can be observed and that all efforts should be made to do this as well as possible. You are deeply convinced that the expert must treat his instruments as precious possessions which must be used for programs to which they are best suited and not for programs which he might like best. You have therefore always sacrificed your own preference for the sake of astronomy. In this lies a part of your greatness. If one works hard, as you often used to say, one always finds something and sometimes something good.

"When I began to ponder what I should say today my spirit was high because never before had I had so much in mind that I would like to say. But when I got down to drafting my speech, my courage waned. How could I do justice to the overwhelming amount and variety of work you have done in astronomy? It was a consolation to find that the Reverend Mr. Phillips complained similarly when he presented you with the Gold Medal of the Royal Astronomical Society in 1929. And what an enormous amount has been added to your work in the last 17 years!

"Time permits mention of only a few of your discoveries. In the first place there is the discovery, made before the beginning of your real career as an astronomer, of the so-called giant and dwarfs. This you based upon the fact that among the stars having temperatures equal to that of the sun or lower there are two classes which differ strongly in total brightness. The 'Hertzsprung-Russell' diagram which developed from this discovery is destined to remain important in the investigations of the evolution and development of the stars. Later on you added to this work through the investigations by yourself and your students on the effective temperatures and magnitudes of stars in cer-

tain star clusters, such as the Pleiades. With your discovery of the supergiants and c-stars you laid the foundation for the measurements of luminosity by means of the properties of the spectrum, a method which later under the name of 'spectroscopical parallaxes' had a wide influence. In 1913 you determined the intrinsic luminosity of the peculiar pulsating stars, the Cepheids, which you then used as a scale to determine the distance of the Small Magellanic Cloud, a distance of 80,000 light years, the first distance measure which brought us outside the immediate surroundings of the Milky Way. The method introduced here became the basis for all measurements of very large distances, in the galactic system as well as in the expanding universe of spiral nebulae.

"I mention further the discovery of new members of the Ursa Major group. For example, you noted that the star Sirius, lying far from the Ursa Major constellation, should be included in this group of stars. Of the countless investigations of variable stars made by you and your students I mention only the investigation of the relation between the form of the light curve of a Cepheid and its period, an investigation based to a large extent on your own material. Again, in another field, you were the first to call attention to the remarkably close connection existing between the mass and the luminosity of a star, which under the name of the mass-luminosity relation obtained so great importance.

"It is in the first place your great skill as a practical observer and your ingenious ideas for bringing the accuracy of observation to hitherto unknown heights, which made us think of a comparison with Tycho Brahe. I think of the use of the objective grating for the measurements of magnitude and effective wave length. The idea originated with your admired teacher, Karl Schwarzschild, but it was you who brought it into the world and who showed its numerous applications. I think also of your pioneer work in the field of photographic double star measures. Here you have indeed succeeded in bringing the accuracy one decimal place further. You have determined positions of double stars with a mean error of a few thousandths of a second of arc. If I well remember, Tycho succeeded in determining positions with an accuracy of a minute of arc. The inaccuracy of Hertzsprung's measures are certainly a factor ten thousand times smaller. This accuracy you have not only obtained through ingenious refinements, but also through the indefatigable work of more than 600,000 settings. You have never spared yourself tremendous amounts of routine work.

"I could go on talking about your work, but time does not permit. You once told us that Schwarzschild had made a striking comparison between you and himself: 'Hertzsprung thinks always, but I think only occasionally.' In fact, almost every minute of your life has been devoted to astronomy. I would not be surprised if at this moment, to put it mildly, you feel uneasy about the valuable minutes which this afternoon

are being lost to astronomy.

"Professor Hertzsprung, we are proud that you did a great part of your life work in our country and in our observatory. It is certainly on that account that the Leiden Observatory has become such a flourishing and productive center for photometric work. We are thankful for the countless things we have consciously and unconsciously learned from you."

Astronomy in Armenia from the 5th Century B.C. to the 19th Century A.D.*

By L. SEMENOV

A three-volume work on the history of astronomical science in Armenia from the 5th century B.C. to the 19th century A.D., compiled by the author of the present article, will shortly be published by the Academy of Sciences of the U.S.S.R. The historical research necessary for the compilation of this work was begun in 1933, being founded chiefly on the vast data contained in ancient manuscripts and printed materials which I found in the Matenadaran, the famous Armenian book and manuscript repository in Yerevan.

Already in 1926, when I first visited the Matenadaran, which was then housed in the ancient Armenian monastery in Echmiadzin, I was amazed by this unique and vast collection of manuscripts throwing light on the old culture of the Armenian people. The number of manuscripts here equals 42,000. Of these, very many were acquired by the repository during World War I, when the Armenian people, fleeing from the German-commanded Turkish hordes, were forced to leave their homes (Kars, Erzerum, Van, Mush, Bitlis, Malazkerd, Diarbekr and so forth), where their ancestors had lived and worked through the centuries, and to seek shelter in the Transcaucasus or northern Caucasus under the protection of Russia.

Under these grim conditions, when their lives were in constant danger, the fugitives nevertheless did not forget their cultural heritage and carried away with them the manuscripts and books which had been preserved in monasteries and churches, then the cultural centres of so-called "Turkish" Armenia. The history of these manuscripts resembles as tragic an epic as the history of the Armenian people themselves.

In the course of many years spent in Armenia, I learned both the living Armenian language and Old Armenian, which enabled me to read the manuscripts in the original, this being very important as the

*Issued by Press Service Department of Soviet News.

published translations were not always satisfactory, the very conscientious and zealous editors, not always being specialists in one or the other branch of science, frequently through no fault of their own allowed mistakes to pass.

Already at the beginning of my work in the repository I was struck by the comparatively large number of manuscripts on the so-called "tomar," . . the science of chronology and compilation of calendars, and also on astronomy and mathematics. These manuscripts had been classified according to departments, while the astrological works had been erased from the list of documents to be studied. It was decided that the first volume of the history of Armenian astronomy should be devoted to the "tomar" department as being the richest.

I must mention here that I had always been surprised by the profound knowledge of all questions connected with the calendar that was displayed by even semi-literate Armenian peasants. An investigation later carried out showed that in their calculations they used rules indicated in the ancient manuscripts. It was thus established that in ancient Armenia science was popular with the wide masses of the people and that the rules worked out by the learned astronomers were handed down by word of mouth from generation to generation.

In the course of my work I set myself the task of giving a clear and concise description of the system of the ancient Armenian calendar, to throw light on obscure questions and establish the chief landmarks on the basis of which Armenian historians would be able to work out a correct chronology of historical events. I think that I have succeeded in solving these problems.

In the first place, the precise date of the beginning of the Armenian chronology was established (the middle of the 5th century B.C.). The Armenian method of chronology resembled the Egyptian with certain differences—the Armenians calculated from the heliacal rising of the constellation of Orion (Hayka in Armenian) instead of the Sothic-cycle (Sirius) used in Egyptian chronology, and so forth. This national Armenian calendar functioned until 1318, when it was replaced by the Julian year which previously had only been used in church practice.

The Armenians consider that their era began in 552, although certain Armenian historians (Stefan Asokhac, Kirakos Gandzaketsi, and others) indicate 553. Our research, however, has established that the first year of the Armenian era was, in reality, 554 A.D.

The book gives a detailed account of the works of famous Armenian calendar experts, such as Ananin Shirakatsi, Ovanes Kozern, Ovanes Sarkavag, Akop Krimetsi, Azari Djugaetsi, the catholic Simeon of Yerevan, and others. The meaning of the terms used in the Armenian calendar, which do not resemble those used by other peoples, have been determined, and light has been thrown upon a number of other specific features of the calendar of the Armenian people. A table for use in the

calculation of chronological dates is given at the end of the volume.

The first volume of the history of Armenian astronomical science consists of eight signatures.

The second volume contains an outline of astronomical science in Armenia, from the beginning of the fifth century B.C. to the 19th century A.D. Special chapters are devoted to the following subjects: a) the determination of the length of the year; b) the apparent path of the moon and the calculation of its rising and setting; c) the apparent paths of the planets and the sun; d) the inclination of the equator to the ecliptic; e) the path of the sun around the ecliptic; f) the distance of the planets, the sun, and the moon from the earth (so-called astronomical geometry); g) solar and lunar eclipses and their forecasts; h) the constellations and the sphere of the fixed stars and so forth.

In this volume much attention has also been devoted to the works of Armenian astronomers of different epochs, as well as to works not of a purely astronomical nature but dealing with astronomical questions. These include the works of the non-astronomer Eznik Kokhpatsi of the fifth century; Anania Shirakatsi, astronomer and mathematician of the seventh century; Arakel Sinetsi of the ninth century; Nerses Shnorali who lived in the 12th century and, without being an astronomer, provided much interesting scientific information in his beautiful poem on "The Ornaments of the Firmament"; Ovanes Erznkatsi of the 13th century; and others. . . An interesting example of Erznkatsi's great learning is that part of his work in which he gives a very exact description of polar lands, or to quote the author's own words: "the lands which are cellars of frost and creators of the weather"—a definition remarkably near to our modern views.

A special chapter in the second volume is devoted to the Armenian translation of the works of Peter Apian, professor of Astronomy and Mathematics in Ingolstadt, "Cosmographie seu descriptio totius orbis," and "Astronomicum Caesareum," issued in Bavaria in 1540. These works were translated into the Armenian language (Manuscript No. 1780 in the Matenadaran) in 1621 in the Monastery of the Sacred Cross in the ancient capital Ancyra, now Angora. Another chapter deals with the work of the Armenian astronomer Naldjian, which was published in Vienna in 1945. The second volume contains 25 signatures. The third volume will include translations of certain texts into Russian with comments.

A New Aspect of the Sun as a Variable Star

By JAMES C. BARTLETT, JR.

When we speak of the sun as a variable, the astrophysicist is apt to think in terms of variations in the solar constant while the ordinary observer perhaps thinks of the celebrated sunspot cycle. But there may be other variations, perhaps undreamed of in our present philosophy, which are just as important and fundamental. The writer believes that he has established at least one such variation of cyclic nature which at the present time forms the basis of a new and interesting study.

If one observes the sun with even a small telescope, 2 inches aperture will do, it is evident that the surface of the photosphere far from being smooth and uniform in texture is mottled all over with a mixture of bright points and dark pores. This characteristic appearance has been described as resembling "snowflakes on a gray cloth," "nodules studding the surface of the sun," and even as "willow leaves"; but perhaps the most graphic description was given by the late Simon Newcomb who wrote that the photosphere looks "like a fluid in which ill-defined rice grains are suspended." He also put it more simply by saying that "the sun looks like a plate of rice soup."

These "rice grains," which often form the subject of earnest inquiries by observatory visitors, amazed to hear that there is "rice" on the sun, constitute the granulation of the photosphere; and there are certain variations in this granulation which are under study by the writer and those assisting him.

The very earliest telescopists appear to have missed the granulated structure of the photosphere, which is not surprising when one considers the delicacy of the phenomenon and the crudity of the first telescopes. However, as instruments improved, it was soon noticed that the surface of the sun appeared to be broken up into luminous points and dark pores, though no serious study was attempted until the time of Herschel.

Just when the granulation was first detected is a moot question. One of the first observations was made by a certain Mr. Short, an Englishman, who saw it at the solar eclipse of 1748 and described the classical appearance very completely and accurately. Herschel took up the subject and published two papers, 1795 and 1801, in which he spoke of "nodules" studding the surface of the sun. In 1830, Dawes, another celebrated English observer, began to observe the phenomenon and found that the photosphere was composed of irregular granules. Just one year later, in 1831, Schwabe, the German discoverer of the periodicity of sunspots, described a banded structure in the granulation "like two freckled girdles around the sun."

The early telescopes being what they were, it is natural that many confused views were held. Thus while Herschel spoke of "a mixture of small points of unequal light" and later on of "nodules," and Dawes saw "luminous clouds," Nasmyth, in 1861, startled the astronomical world with the announcement that the "nodules" and "granules" were really shaped like "willow leaves" with pointed ends. He regarded the granulation as arising from the interlacing of these "leaves" much like the thatching of straw.

The strange announcement of Nasmyth "excited a good deal of pretty warm discussion," as Young put it, and Dawes flatly denied the existence of anything remotely resembling such objects. Father Secchi, however, while not wholly admitting Nasmyth's "willow leaves," thought that the granules were shaped something like rice grains and also declared that they were much smaller than supposed by Nasmyth who had assigned lengths up to several thousand miles.

All of this ferment, however, was beneficial in that it stimulated closer investigations into the true nature of the photospheric granulation. Presently it came to be recognized that the granulation was highly complex rather than simple and a corresponding change in nomenclature followed. Hitherto rough terms had been used loosely to describe "nodules," "grains," "granules," etc., but now a distinction was made and terminology was accordingly restricted.

The granulation was divided into "three orders of aggregation" as Newcomb described them: cloud-like forms, grains, and granules. The clouds make up the granulation which is seen with a small telescope, and it is this granulation which is under study by the writer and those assisting him as will appear later. The grains are still smaller forms into which the clouds are resolved with sufficient power; and finally the grains themselves, on rare occasions, are resolved into still smaller granules. Langley, of the Allegheny Observatory, pioneered in the minute anatomy of these granules and estimated that they were responsible for at least 75% of the solar light. He found them to be of the order of a third of a second of arc in diameter, while Secchi thought them even smaller.

When we speak of the granulation in the ordinary sense of the word, we refer to the coarsest of Newcomb's "three orders of aggregation," *i.e.*, to the cloud-like forms which average 1 to 2 seconds of arc in diameter and which may be seen in little clusters with 2 inches of aperture. The finer forms into which these may be resolved are, of course, quite beyond small instruments and even today there is much confusion in nomenclature, "grains," "granules," and even "nuclei," being used interchangeably by one authority or another; but fortunately for the investigation being conducted at present such discrepancies are of no importance since it is only the coarsest granulation which is observed.

One of the first discoveries made in relation to the granulation was

its variability, though it does not appear that *regularity* in variation was suspected. Indeed it was commonly assumed that the observed variations were due entirely to atmospheric conditions, both solar and telluric, and the former view was greatly strengthened by the work of Janssen, Director of the Physical Observatory at Meudon, France.

Using only a 5-inch telescope with an enlarging lens, Janssen pioneered in the taking of remarkably good photographs of the sun to half a meter in diameter which were noted for the great clarity of detail. By this means he discovered the *reseau photospherique,* or photospheric network, which was recognized as a new phenomenon. Briefly, the appearance was as of smudged or foggy areas affecting the photosphere unequally so that the granulation appeared more distinctly in some areas than in others. This appearance was ascribed to overlying vapors in the sun's atmosphere and Young even spoke of "smoke," basing himself partly on a remarkable paper by a certain Professor Hastings of Baltimore, who, in 1880, published a novel and rational theory of granulation.

This theory of Hastings deserves some attention because it appears to have been the forerunner of the somewhat similar modern theory of ionization levels in the sun's atmosphere. According to the views of this early Baltimorean, convection currents start at a level which is well above the vaporizing temperatures of all substances (we would say above the ionization temperatures) and move upward into regions of lesser density. Here the vapor currents are cooled by expansion and condense, thus precipitating out various substances at various levels corresponding to those temperatures at which the given substances will precipitate. (We have here an analogy with the modern theory of ionization levels according to which there are levels at which all substances are completely ionized, partly ionized, and not ionized at all.) Hastings regarded the visible granulation of the photosphere as being composed of precipitates of carbon, silicon, and boron. These precipitates he thought caused the granular appearance.

Hastings' theory was perhaps rather too simple, though it must be remembered that this paper appeared five years before Arrhenius postulated the existence of ions to explain conductance in electrolytes and some thirty years before Rutherford gave us the first really modern picture of the atom. Be that as it may, the granulation of the photosphere came to be regarded as due essentially to individual cloud-like masses floating in a solar atmosphere. Some authorities regarded the granules as the tops of ascending currents of incandescent matter, while others thought of the pores between them as the true granules. The work of Hale, Tacchini, and others confirmed upward movements extending even above the chromosphere, though it soon came to be recognized that simple convection could not explain some of the observed velocities of chromospheric matter. Electrical repulsion and even radi-

ation pressure were called in to explain what was observed.

This leads up to a thought which occurred to the writer in 1939. Since the solar constant is known to vary, and since the phenomena of sunspots and prominences alike display periodicity, it would appear that the sun is inherently a variable star in so far as these particular phenomena are concerned. What if it should prove to be variable in still another respect? And what if this hypothetical variation should prove to be related to the periodical variations in spots and prominences? Armed with this thought the writer decided to begin a series of regular observations of the granulation, and this work was first undertaken alone under the auspices of the American International Academy, Inc., of which the writer was and is a member.

No attempt was made to observe the granulation minutely, *i.e.*, to resolve it into its various constituent parts. Rather it was desired to fix upon some method of observation which would detect *gross variations in the visibility of the phenomenon over the whole disc of the sun*. Such variations, if discovered, could then be compared with the sunspot cycle in order to determine whether one phenomenon appeared to influence the other; or, more correctly, whether both were expressions of some underlying prime cause.

The question of aperture was important. Since the hypothetical variations would be variations in brightness, it is clear that a large glass might well miss them altogether. On the other hand, a very small glass would not show the granulation well enough *consistently* to make day-to-day comparisons possible. After some experimentation it was found that 2 inches would just show the granulation as a delicate mottling all over the disc, and this was fixed as standard aperture with approximately f/15.

The theory of the observations was as follows: If 2 inches would just show the granulation a level of visibility would thus be established which would act as a kind of optical barometer to detect changes in the degree of visibility. It is clear that anything which operated to bring the granulation below this level would cause it to disappear; and conversely, if invisible, anything which operated to bring it above this level would cause it to appear. Thus, by theory, it would be possible to observe any regular fluctuations which might occur.

The year 1939 was spent in daily observations, weather permitting, of the granulation and it was not long before unquestionable variations in visibility were noted. In order to check against definition, a daily record was kept of the state of definition at the time of observations. Definition was broken down as follows: excellent—when the limbs of the sun appear sharply cut; good—when there is a minimum of disturbance at the limbs; fair—when the limbs are much disturbed and there is some difficulty in making out the details of small spots; poor—when there is "boiling" at the limbs and all but grosser spot details are

lost. By the end of 1939 it was apparent that the curve of granular visibility did not follow the curve of good definition but appeared to be quite independent of it.

It was also apparent that the curve of granular visibility *did* follow the curve of spot activity, though not precisely. While it was impossible to make an exact correlation between granular visibility and spot activity, because of a marked lag between the two, in general it was easy to see that the granulation was visible *for a greater number of days when spots were active* than for a period when they were small and infrequent. This suggested that of any given year the number of days of granular activity should be less during a minimum spot cycle than for a maximum, and this subject is under investigation at the present time.

Satisfied that a variation in granular visibility had been established, and that such variation roughly followed the curve of spot activity, the writer reported his findings to the Academy which generously provided funds for regular observation forms which the writer designed to bring out all salient relations. As presently designed, these forms show the following data: date of observation; number of spots visible for the whole disc; state of the granulation (if visible a red "P" is marked in the appropriate column for "present"; if absent, a blue "A"; phase of spots by hemisphere—positive if they are increasing in size or number or both, minus if they are declining, and "E phase" if they are in equilibrium, *i.e.,* doing neither. A hemisphere is said to be in "plus phase" when *any* of its spots show growth, since it is obvious that the ultimate causes of spots operate for a hemisphere as a whole; in minus phase when *all* of its spots show decline; and in "E phase" when the spots show no significant changes in size or shape for several consecutive days. Obviously "E phase" is the rarest and is practically confined to the minimum period when only one spot at a time may appear, or to the infrequent periods of a maximum cycle when lone spots or at most one or two are seen.

The form also provides columns for the state of definition, and the mean local temperature at the time of observation, this being the air temperature taken in the shade. The purpose of this is to determine if variations in local temperature so affect the seeing as to cause apparent variations in the visibility of the granulation. It is clear that this column will show seasonal as well as diurnal variations if any. So far no connection has been found. The remaining columns are devoted to mean time of observation, aperture used, and space for remarks.

In using this form determinations are made as follows: at the end of a month the daily spot counts are totalled and the sum is divided by the number of observing days in the month; this gives what the writer calls a mean spot index for that month. This index is then compared with the number of days with granulation "present" or "absent." At

the end of the year the mean spot indices are totalled to give a grand spot index for the year. The number of days in the year with granulation "present" or "absent" are likewise totalled and compared with the grand spot index. In this way it is possible to detect a relationship between the mean spot index and the granular activity. It has been found that the number of days with granulation "present" is consistently higher with increase in value of the mean spot index and *vice versa*, and this is independent of the state of definition unless hopelessly poor.

Not only was such a relation thought to be established but the writer noticed *degrees of change* in the appearance of the granulation. In general it was coarser-grained during times of great spot activity and generally so in the neighborhood of spots (although some remarkable exceptions have been noted). During times of little spot activity, the granulation appeared much finer-grained. When extremely fine-grained it shaded off into complete invisibility. Again, it was found to be variable in the area affected. During times of marked spot activity it was generally seen all over the disc; but at other times it appeared in patches, localized around spot groups, and occasionally strongly banded in the sunspot zones—an appearance which Schwabe had noted in 1831.

Among the curious facts established by these observations was the pronounced "lag" in granular activity as compared with spot manifestations. Although the monthly and yearly summations showed a definite trend towards increase in granular activity with increase in spot activity, it was generally impossible to correlate for any given day. Thus, the granulation would sometimes begin to coarsen several days in advance of a great spot outburst while at other times it *followed* such an outburst by several days. On the whole it was found that when the granulation coarsened before the appearance of active spots it would reach its peak before the spots had reached theirs, while if it followed a spot outbreak it would reach its peak after the spots had reached theirs.

Nevertheless it was often possible to predict in advance the development of new spot groups by watching the granulation change from fine through medium to coarse-grained; and often the approach of a large group to the following limb was thus announced by the appearance in advance of a coarse granulation. Conversely, a general decline in spot activity was often heralded by a sudden drop in the granulation from coarse to fine-grained status.

It is a rather remarkable fact that the granulation would often be affected simultaneously all over the disc. When we consider what this means in terms of the sun's surface area it is clear that the changes observed must have been due to some fundamental factor affecting the sun as a whole. At other times, however, the granulation would appear patchy, banded, or confined to areas containing spot groups. It was not unusual to see it coarse in one hemisphere and fine-grained in an-

other.

While these observations opened a new field for solar investigation and appeared to establish a new phenomenon, namely the cyclic character of granular variation, they labored under the disadvantage of having only one observer as authority. This disability, however, was happily removed.

During the spring of 1944, while attending an astronomical meeting at the Science Service Building in Washington, D. C., Dr. Donald H. Menzel, who had taken an interest in the work, suggested that the writer join forces with the newly established Solar Division of the A.A.V.S.O. and kindly offered to sponsor him for membership.

This suggestion was particularly valuable for a number of reasons. For one thing the work of a single observer can never be wholly freed from personal equation. For another, when all observations are made from one station, so many days are apt to be lost through bad weather that the record is apt to be very sketchy so that it becomes difficult to establish any periodic phenomenon. Again, for the same reason, it becomes impossible to eliminate from the observations the influence of what may be called the climatic factor in definition. Thus in Baltimore, being on a large river and adjacent to a great bay and not very far from the ocean itself, the atmosphere is characterized by a general humidity. It is clear, therefore, that conditions of good definition at Baltimore are not apt to be the same as those for a station in a dry climate. At any rate the writer became a member of the A.A.V.S.O. in due course.

Thanks to the efforts of Mr. Neal J. Heines, Chairman of the Solar Division, other A.A.V.S.O. members were soon attracted to the new study. The first to volunteer was Mr. Bert Topham of Toronto, Canada; followed by Mr. Buckstaff of Oshkosh, Wisconsin, and Mr. Rosebrugh of Waterbury, Connecticut. Recently Mr. James Hillebrand of Detroit, Michigan, volunteered for granulation work and it is hoped that there will be others.

Since the collaboration of these observers the writer has been greatly assisted in his studies. For one thing it is now possible to report for practically complete months, a cloudy day at one station frequently being balanced by a clear day at another. For another, the observers being widely seprated, it is possible to get a better check on the effect of definition on granular visibility.

All the observers use the standard form for reporting results, and all observers, except Mr. Buckstaff, use the standard 2-inch aperture. It is pleasant to report that the combined work of all the observers has certainly confirmed the fact that the granulation does vary in visibility. All the observers too have noticed the varying degrees of fineness and coarseness in the granulation, and all of them have confirmed its occasional patchiness, localizations, and the banded structure. It is planned to observe through at least two cycles, maximum and minimum, before

anything definite is said about correlation between granular activity and spot activity; but it may be said at this time that all the observers are so far in agreement that the number of days with granulation "present" is higher for higher spot indices. There has also been remarkably good agreement as to the nature of what is seen, *i.e.*, whether the granulation is fine, coarse, questionable, and so on. Discrepancies have been few.

It may be taken as an established fact that the granulation, when observed with the aperture described, and by direct view, varies markedly in visibility and that these variations appear to be largely independent of the state of definition. It is also at least indicated by the work of all the observers that the visibility percentage of the granulation varies with the increase and decrease in spot activity. How then may such facts be explained?

One thing must be fixed clearly. Variation in spot activity does not *directly* cause a corresponding variation in granular activity. This is obvious from the fact that the spots are *local* areas of disturbance, whereas the granulation is affected over the entire disc. Nevertheless there appears to be a relation between the two, and this can only be explained on the assumption that *both* phenomena are responding to a common influence as yet undetermined. In other words, whatever it is that gives a cyclic character to spot phenomena does so to the granulation.

As to the physical nature of the variation in granular visibility little that is positive can be said at this time. It is clear that when the granulation is established at a mean level of visibility anything which causes it to fall below that level must be in the nature of a decrease in light or in size of the individual granules. While there may be a relative decrease in light, it is obvious that this factor is comparatively unimportant, else the sun would exhibit an easily recognizable variation in magnitude. On the other hand it is difficult to imagine a cause which would make the granules smaller or larger on occasion.

Yet it is a fact that they *appear* so to vary in size, the granulation at times being obviously coarser-grained than at other times. It is the writer's thought that the observed variations may be explained by supposing *a change in level.* At the highest level there would be necessarily more room for expansion and so larger granules would be possible than at a lower level where they would be more crowded together. If this theory is tenable, it follows that the observed variations in granular visibility are due to variations in the mean level of the granulation in or above the photosphere.

In other words we are to imagine a cloudy shell which is subject to expansion and contraction within what are probably narrow limits; a *pulsating* shell of cloud-like forms (or granules), the impulses of which are probably keyed to the fundamental rhythmic pattern of the spot

cycle. In this view the sun may be compared to a Cepheid variable of very low amplitude. In this view also the granulation level is higher during a spot maximum and lower during a minimum. However, Dr. Menzel thinks this picture is not justified, and regards the theoretical changes in elevation as being due to turbulence.

Several lines of investigation are suggested by the present study, which are beyond the scope of the observers engaged in the present work. It would be extremely interesting to compare variations in the solar constant with variations in granular visibility. Again, it is important that spectroscopic studies of the photosphere be applied to determine whether there is such a pulsation as suggested above. Finally, it might be interesting to select a number of stars of the same spectral class mass, and density as the sun and by refined methods seek to determine very slight variations in their apparent magnitudes.

300 NORTH EUTAW ST., BALTIMORE 1, MARYLAND.

The Planets in September and October, 1947

By RAYMOND H. WILSON, JR.

NOTE: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. The beginning of this period finds the sun still far enough north to produce summer heat; whereas at the end of October it will be 14 degrees south of the equator—well over half way to its winter position of minimum radiation for the northern hemisphere. The autumnal equinox, that is, its actual crossing the equator, occurs on September 23 at 3 P.M.

Moon. The phases of the moon will occur as follows:

Last Quarter	September	7	10 P.M.
New Moon		14	1 P.M.
First Quarter		21	11 P.M.
Full Moon		30	1 A.M.
Last Quarter	October	7	4 A.M.
New Moon		14	1 A.M.
First Quarter		21	7 P.M.
Full Moon		29	2 P.M.

Perigee occurs on September 12 and October 9.

A grazing occultation of ϕ Sagittarii may be seen from the southern part of the United States on September 22 just before 10:00 P.M. Also, η Leonis, the star marking the joint of blade and handle of The Sickle, will be occulted on October 10 at about 4:00 A.M.

Evening and Morning Stars. Jupiter will be the most brilliant evening star at the beginning of this period, but at the end it will be outshone by Venus which will be approaching Jupiter from the right in the western evening twilight. Mercury also may be seen in this part of the sky in October. In the morning sky Mars will be approaching Saturn from the westward.

Mercury. It happens that this period almost exactly covers a usual two-

month period during which Mercury lies eastward of the sun. On October 13 it reaches a greatest elongation of 25 degrees east, but because of its 20 degree southern declination in Libra, it will be very close to the southwestern horizon at dark. Search at this time may be aided by the much more brilliant planets Venus, 15 degrees to the right, and Jupiter, 15 degrees to the left; also on October 15 it will be 4 degrees south of the crescent moon. After starting retrograde motion it will pass less than 3 degrees south of Venus on October 28.

Venus. Since it passes superior conjunction with the sun on September 3, Venus will be practically invisible until about the middle of October, when it will be low in the southwestern twilight. On October 28 it will be in conjunction with Mercury.

Mars. As the most conspicuous morning planet, Mars will be in 20 degrees north declination and just east of the meridian at sunrise. At the end of this period it will have approached from the right to within 5 degrees of Saturn.

Jupiter. During this period Jupiter at sundown will pass from a very favorable position just west of the meridian to a comparatively low altitude in the southwest. Toward the last of October, however, interest will be revived by proximity of Venus and Mercury. On September 18 and October 16 the crescent moon will pass only a degree to the south of it.

Saturn. The time of Saturn's rising changes from 4 A.M. at the beginning of this period to shortly after midnight at the end. On this late date it will be about midway between Regulus and Mars.

Uranus. Uranus reaches a stationary point, about 4 degrees northwest of ζ Tauri, on October 3.

Neptune. Since Neptune passes conjunction with the sun on October 4, it will be practically unobservable during this period.

Department of Mathematics, Temple University, Philadelphia, Pa.
July 2, 1947.

Occultation Predictions for September and October, 1947

(Taken from the *American Ephemeris*)

Date 1947	Star	Mag.	IMMERSION Greenwich C.T.	IMMERSION *a*	IMMERSION *b*	IMMERSION Angle E from N	EMERSION Greenwich C.T.	EMERSION *a*	EMERSION *b*	EMERSION Angle E from N
			h m	m	m	°	h m	m	m	°
	Occultations Visible in Longitude +72° 30′, Latitude +42° 30′									
Sept. 8	103 Taur	5.5	7 25.1	−0.8	+1.5	75	8 34.7	−1.1	+1.7	246
11	λ Canc	5.9	8 11.6	+0.5	+2.8	42	8 48.2	−1.1	−0.7	325
23	248 B.Sgtr	5.6	23 27.5	−2.2	0.0	107	0 50.3	−1.8	+0.3	236
27	69 Aqar	5.8	22 25.8	−0.6	+1.5	86	23 32.8	−1.0	+2.0	228
27	τ Aqar	4.2	23 58.0	−1.0	+2.3	28	1 3.0	−2.0	+0.9	277
Oct. 5	τ Taur	4.3	2 9.6	+0.2	+1.2	87	3 0.5	+0.2	+1.8	233
6	139 Taur	4.9	9 8.3	−2.2	−1.1	118	10 14.1	−1.8	+2.0	227
7	39 Gemi	6.1	7 51.4	−2.3	−2.2	146	8 27.7	..	..	206
8	4 Canc	6.2	7 41.6	+0.1	+4.1	34	8 16.0	−1.8	−2.1	332
10	η Leon	3.6	10 38.8	−1.2	+0.1	117	11 52.2	−1.6	0.0	290
11	BD+12°2284	6.4	9 19.4	−0.2	+2.2	70	10 4.7	−0.7	−1.2	336
20	τ Sgtr	3.4	21 4.5	−1.9	−0.7	138	22 3.1	−1.9	+1.2	217
22	86 B.Capr	6.2	21 59.5	−2.0	+0.5	104	23 15.3	−1.6	+1.2	219
31	13 Taur	5.5	10 32.1	−0.6	−0.9	78	11 32.9	−0.2	−0.9	254
31	56 Taur	5.3	23 32.9	+0.4	+1.3	72	0 23.7	+0.2	+1.5	246

Date 1947	Star	Mag.	IMMERSION Greenwich C.T.	IMMERSION *a*	IMMERSION *b*	IMMERSION Angle E from N	EMERSION Greenwich C.T.	EMERSION *a*	EMERSION *b*	EMERSION Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′										
Sept. 8	103 Taur	5.5	7 13.1	0.0	+1.9	55	8 12.4	−0.8	+1.3	266
23	248 B.Sgtr	5.6	22 53.1	−1.3	+0.4	120	0 9.3	−2.3	+1.3	237
27	τ Aqar	4.2	23 35.1	−0.7	+2.4	32	0 31.9	−1.0	+1.1	283
Oct. 6	139 Taur	4.9	8 31.5	−1.7	+0.3	106	9 38.7	−1.4	+2.4	229
7	39 Gemi	6.1	7 22.5	−1.0	+0.2	123	8 11.9	−0.2	+2.7	224
10	η Leon	3.6	10 20.6	−0.7	+0.1	124	11 25.0	−1.1	+1.0	275
22	86 B.Capr	6.2	21 28.1	−1.1	+0.8	112	22 37.5	−1.9	+2.0	224
31	13 Taur	5.5	10 18.3	−1.2	−1.3	94	11 23.1	−0.9	+0.1	233
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′										
Sept. 22	4 G.Sgtr	6.2	1 50.7	−2.4	−0.6	112	3 22.2	−2.1	−0.4	259
Oct. 1	μ Pisc	5.1	13 44.0	−0.6	−2.9	116	14 22.3	−0.3	+2.1	192
5	99 Taur	6.0	8 40.6	−1.8	+0.1	114	9 29.3	−0.1	+3.4	201
6	139 Taur	4.9	7 59.7	−0.2	+1.4	75	9 1.8	−0.7	+1.5	256
7	39 Gemi	6.1	7 10.2	+0.2	+0.9	93	8 2.5	+0.1	+1.4	254
7	40 Gemi	6.3	7 33.8	−0.6	−0.4	139	8 3.8	+1.0	+2.9	207
9	90 H¹ Canc	6.1	11 48.7	−0.8	+1.2	87	12 56.4	−1.4	−0.2	299
26	336 B.Aqar	6.5	6 12.9	−3.9	−2.0	110	6 54.0	+0.9	+3.8	171
31	13 Taur	5.5	9 26.6	−2.4	−0.2	91	10 40.0	−1.6	+1.7	219
Occultations Visible in Longitude +98° 0′, Latitude +30° 0′*										
Sept. 22	4 G.Sgtr	6.2	2 55.0	−2.6	−2.5	133	3 52.9	−0.3	+0.8	221
23	248 B.Sgtr	5.6	22 53.8	+0.4	−3.2	160	23 27.0	..	..	205
26	33 Capr	5.5	7 7.3	−0.5	+0.4	49	8 14.1	−0.4	−0.5	253
29	376 B.Aqar	6.3	8 44.4	−1.5	−0.3	74	9 51.5	−0.4	+1.0	214
Oct. 6	139 Taur	4.9	8 20.8	−2.8	−1.7	134	8 59.2	..	..	197
7	39 Gemi	6.1	7 21.2	−2.7	−3.5	155	7 39.0	..	..	189
8	4 Canc	6.2	7 15.7	+0.8	+2.3	43	7 54.0	−0.9	−0.7	316
9	90 H¹ Canc	6.1	12 16.1	−1.9	−0.4	116	13 38.7	−2.3	−0.3	284
10	η Leon	3.6	10 23.6	−1.1	−2.6	163	10 58.9	−0.5	+3.6	231

*Computed by Edgar W. Woolard and Paul Herget; communicated by Commodore J. F. Hellweg, Superintendent U. S. Naval Observatory.

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Comet Notes

By G. VAN BIESBROECK

There are a great number of faint comets observable at this time but none come in reach of moderate-sized instruments.

In the evening sky Comet 1947 *d* (Bester) is gradually fading. When last

recorded here on July 7 it appeared as a small condensation in a very faint coma; the total light corresponded to a stellar magnitude of 15. It will soon be lost in the twilight.

In the middle of the night three faint comets are being watched: COMET 1946 *h* (JONES) which was found last August in the southern hemisphere is now very well placed for northern observers but not brighter than magnitude 14 (July 7).

The first observation of the expected PERIODIC COMET WHIPPLE has been obtained at the Lick Observatory on June 21 by Jeffers, who estimated the magnitude as faint as 18. Independently the writer picked it up on June 25 as a small fuzzy spot of magnitude 17. This is the second return of this periodic comet since its discovery in 1935. It is not expected to become much brighter than 16th magnitude.

PERIODIC COMET 1947 *a* (GRIGG-SKJELLERUP) is still well placed for observation in the middle of the night but is now reduced to 15th magnitude and rapidly losing in light (June 25).

In the latter part of the night COMET 1947 *b* (RONDANINA-BESTER) will remain visible for several months more. On the morning of eclipse day, May 20, I saw this object with the naked eye just before dawn from the Bocajuva (Brazil) eclipse camp. The tail could be followed over some three degrees with binoculars. On June 25 the comet still showed a well-developed tail. That morning the magnitude was estimated at 8.2. However the comet now fades rapidly. By August it will have dropped to magnitude 12.

Also in the morning sky the expected PERIODIC COMET 1947 *f* (FAYE) has been recovered June 19 by Jeffers at the Lick Observatory. The object is described as centrally condensed and of magnitude 17. According to L. E. Cunningham this observation shows that perihelion passage will occur September 27.80 which is 2.20 days later than was predicted by Beart and Henderson (*B.A.A. Handbook*, 1947). The following ephemeris is corrected accordingly:

1947		α h m	δ ° ′	Mag.
Aug.	3	3 10.0	+19 54	15.8
	11	3 31.1	20 25	15.6
	19	3 52.4	20 41	15.4
	27	4 13.3	20 41	15.2
Sept.	4	4 33.9	20 24	15.0
	12	4 53.7	19 51	14.9
	20	5 12.6	17 56	14.8
	28	5 30.0	16 38	14.7

Under the signature of three Russian astronomers a radiogram was broadcast June 18 announcing the discovery of an 11th magnitude comet in Ophiuchus by Jakovin, Jr. I did not succeed in locating such a comet and since no other information has been forthcoming this object remains unconfirmed.

PERIODIC COMET ENCKE will soon be bright enough in the morning sky to be recovered. Exposures obtained here showing stars as faint as magnitude 15 failed to reveal the presence of the comet on June 25.

Williams Bay, Wisconsin, July 12, 1947.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

These Notes will contain all the remaining reports on counts for the great shower of 1946 October 9. It is hoped soon to begin a general discussion of the data.

The writer's second paper, "Long Enduring Meteor Trains," has now had the first proofs corrected, and will appear this fall in the Proceedings of the American Philosophical Society. It will later be distributed as Flower Observatory Reprint No. 69 to the regular official observatory mailing list and to active A.M.S. members. The first paper on this subject went out as Reprint No. 60. Any person who possesses No. 60 should secure a copy of No. 69 when available, as there are numerous corrections to the former paper as well as new material.

A good report on work done in 1946 was unintentionally omitted when the annual report was published in the April Meteor Notes. This was by M. G. Wright of Plevna, Ind., with observations on three nights. On Nov. 14 from 14:05 to 15:05, Moon about full, only one Leonid was seen. This of course confirms that the rate was very low, as indeed expected during these years. On Nov. 27, from 14:00 to 15:22, $F = 1.0$, 7 were observed, and on Dec. 4 from 14:52 to 16:08, 4 were observed. All the above were plotted.

Both the U.S. Army and Navy undertook extensive observations last October for the expected meteor shower during the interval covering Oct. 8 to 10, inclusive. Unfortunately, at a large majority of the stations, clouds prevented observations. Not to use unnecessary space, I shall condense these reports, copies of which were furnished me, merely mentioning some of those places where either cloudy weather prevailed or so few metors were seen that the results have only negative value.

Taking the Navy reports first, all given in G.C.T., from 13 stations in the Pacific little or nothing was seen; useful reports came from three. In the Philippine Islands at Manila, Sanglay Point, and Samar, 15 meteors in all were recorded on Oct. 8. At Freemantle, Australia, none was seen. At Chinhaunta, China; Sasebo, Japan; Kodiac, Alaska; and a station at $\lambda = 173°$ E and $\phi = 53°$ N none was seen. At Midway Island on Oct. 9 from 0645 to 0655, 3 were observed; at Wake 3; at Guam 1; at Kahulai 4; and at Shanghai 5. In other words at none of these stations did any shower appear. Better fortune was had at San Diego, Calif., where on Oct. 10, from 0230 to 0800 G.C.T., 9 counts were made, each 10 minutes long. The number of observers is not stated but a total of 646 meteors was recorded, the maximum rate being 1524 per hour at 0405 G.C.T. At Pearl Harbor, Oct. 10 from 0450 to 0610, 90 meteors were recorded, the maximum rate being at 0525 G.C.T. and reaching 216 meteors per hour. At an air station near $\lambda = 170°$ W, $\phi = 17°$ N, on Oct. 9 from 0540 to 0830 G.C.T., 35 meteors were observed, with $F = 0.3$. This indicates a rate of 12 meteors per hour. It is interesting as being on the night before the shower. Direct data for F at San Diego and Pearl Harbor are not given, but inferentially it was clear during the intervals mentioned.

The Army reports are more difficult to digest, being partly in code. At practically all of the numerous European posts, as well as many elsewhere, clouds

prevented any success, though there are 81 reports from about half as many stations. My remarks again will be mainly confined to those which were fortunate, though some of the other stations will be mentioned which help define the limits of the shower. There is a further handicap as the state or country in which the airfield or post was situated is not always mentioned and in several cases is unknown to me. Unless otherwise stated these reports are also in G.C.T., so that the date has to be carefully noted, as our A.M.S. reports are usually given in the old astronomical G.M.T., with the day starting at noon. Posts, groups, or airfields situated at the following places had little or no success due to clouds or being outside the limits of the shower: Cairo, Egypt, Oct. 8, 9, 10; Dakar, Africa, Oct. 9; Natal, Brazil, Oct. 9; Ascension Island, Oct. 8 and 10; Waller Field, Trinidad, Oct. 9, 10; Atkinson Field, British Guiana, Oct. 9; Berinquen Field, P. R., Oct. 9; Adak Island, Oct. 8, 9, 10 (all cloudy).

The following had something worthwhile to report: (Correction?) to Ourad, Oct. 10, 0045 to 0100, 30 meteors, maximum rate 6 per minute. (Note: Is there an error in first word? Perhaps an airplane flight was meant.) Zuspitze, elevation 9737 feet, $\lambda = 11°$ E, $\phi = 47°$ N, Oct. 10 (?) 0200 to 0210?, 7 meteors; 0300 to 0310?, 31; 0400 to 0410?, 105; the sky being clear for last two periods. Bremen, Germany, Oct. 9-10, 1810 to 2220, total 30 minutes observing, 0 meteors; 0210 to 0220, 125 meteors seen. Coolidge Field, Antiqua, Oct. 9-10, 2330 to 1200; 60 per hour at 0135; 27 seen from 0320 to 0820 in 50 minutes of actual observing. Great Falls, Mont., Oct. 10, broken clouds in sky, 0315 to 0325, 100 meteors; 0415 to 0425, 50 meteors; 0515 to 0525, 10 meteors. Albrook Field, Panama, 0300 to 0310?, 60 meteors; 0400 to 0410, 12 meteors. Ladd Field, near Fairbanks, Alaska, Oct. 9, 0435 to 0445, 120 meteors; 0835 to 0845, 15 meteors; in one minute at 1234, 37 meteors; overcast rest of the night. These would amount to the following hourly rates: 720, 90, and 2200±??. At another station 26 miles SE of Fairbanks: 0400 to 0410, 145; 0700 to 0710, 45; 1000 to 1010, 12; 1400 to 1410, 10.

At Morrison Field, Fla., we have the following counts made in the 10 minutes after the hour mentioned, for October 9: 0100, 12 meteors; 0200, 24; 0300, 67; 0330, 192; 0400, 182; 0400, 12; 0800, 1. The highest rate was at 0335 and amounted to 1152 per hour. Reports now follow from 5 fields whose localities I do not know, but doubtless can report on in a future Note. Beane Field, Oct. 10, between 0125 and 0650, 80 minutes of observing, 52 meteors seen. Frobaher, Oct. 9, 2235 to 2245 (Local time?) 117 meteors; Oct. 10, 0545 to 0555, 8 meteors. Mingan, Oct. 10, 2330 to 0929, total of 60 minutes observing, 98 seen; maximum rate 510 per hour at 0310. Stephenville Field, Oct. 10, 0045 to 0355, total 50 minutes observing, 110 meteors counted, one or more observers. Vernam Field, Oct. 10, 0100 to 0110, 68 meteors, 0300 to 0310, 182 meteors; 0400 to 0410, 156 meteors; maximum rate at 0305, 1092 per hour.

Orders seem to have been to observe for 10 minute periods every hour, if clear. It will be noted that these orders were carried out pretty rigidly, for even when the meteors were coming at a very high rate, we have no attempt to count for a second period of 10 minutes until the next hour arrived. It is of course a great pity that there was not more elasticity in the directions (which should have been made with help of a competent observer), as valuable data were lost. Also we do not know how many persons observed in each group, indeed if more than one. The rates therefore in the above will have qualitative value only. It is, however, a very good sign that both army and navy authorities decided to cooperate

in a scientific matter on such a large scale, and this cooperation has definite value, as the above résumé shows.

Flower Observatory, Upper Darby, Pa., 1947 July 7.

Contributions of The Meteoritical Society

(Known Formerly as The Society for Research on Meteorites)

Edited by FREDERICK C. LEONARD

Department of Astronomy, University of California, Los Angeles 24

A Catalog of the Meteoritic Falls of the Eleven Western States*

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ABSTRACT AND INTRODUCTION

The following catalog of the meteoritic falls of the 11 Western States gives, in tabular form, the (1) coördinate number; (2) full geographical name; (3) class; (4) number of individual masses; (5) total weight in kilograms or grams; (6) time of fall or find; and (7) principal depository or depositories (if known), of each of the 17 recorded falls of Arizona; the 13 of California; the 41 of Colorado; the 3 of Idaho; the 1 of Montana; the 4 of Nevada; the 31 of New Mexico; the 3 of Oregon; the 6 of Utah; the 2 of Washington; and the 9 of Wyoming—130 in all.

The coördinate numbers have all been independently re-checked since the publication of "A Catalog of Provisional Coördinate Numbers for the Meteoritic Falls of the World" (*Univ. of New Mexico Publ. in Meteoritics*, No. 1, xiv + 54 pp., 1946); hence several of the numbers in the present catalog differ slightly from their counterparts in the forenamed work. A coördinate number followed by a colon (:) is uncertain, at least insofar as its fourth and seventh digits are concerned, while one followed by both a colon and a star (:*) is the coördinate number merely of the "county seat" of the county in which the fall is supposed to have occurred. Two hyphenated county names in the name of a fall (*e.g.*, "Gladstone, Union-Colfax Co., New Mexico") indicate that the town or feature for which the fall was named (*e.g.*, "Gladstone") is in the first-named county (*e.g.*, "Union"), while the place of fall itself is in the second (*e.g.*, "Colfax"). The classificational symbols used are the same as those enumerated and defined on pp. ix-x of the aforementioned "Catalog." Numbers in the fourth and fifth columns, if followed by a colon (:), also are uncertain or approximate. The following special abbreviations are employed: bef.—before; cl.—clâss; C.N.—coördinate number; colln.—collection; dep.—depository or depositories; fd.—find or found; fl.—fall or fell; kn.—known; mi.—meteorite; ms.—mass(es); nr.—near; num.—numerous; or.—original; poss.—possibly; prob.—probably; recg.—recognized; rep.—reported; sev.—several; tl.—total; tm.—time; undet.—undetermined; unkn.—unknown; wt.—weight.

The information contained in this catalog has been derived from all authoritative sources, both published and unpublished, available to the compilers on 1947 June 1.

*Read in abstract at the Tenth Meeting of the Society, San Diego, California, 1947 June 18-19.

A CATALOG OF THE METEORITIC FALLS OF THE ELEVEN WESTERN STATES

ARIZONA: 17 FALLS†

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1126,349	Ashfork, Yavapai Co.	Og	1	29.5kg.	Fd. 1901	1½kg. Am. Mus. Nat. Hist.
1118,346	Camp Verde, Yavapai Co.	Si	1	61.5kg.	Fd. *c.* 1915	
1110,350A	Canyon Diablo, Coconino Co.	Og	Num.	10,000:kg.	Fd. 1891	Over 2300kg. Chgo. Nat. Hist. Mus.; 998kg. U.S. Nat. Mus.; Am. Mi. Mus.; *&c.*
1110,350B	Coon Butte, Coconino Co.	Cgb	1	2.75kg.	Fd. 1905	309g. Chgo. Nat. Hist. Mus.; 200g. U.S. Nat. Mus.
1145,335	Ehrenberg, Yuma Co.	Og	1	4.5kg.	Fd. *c.* 1862	49g. Harvard Univ.; 11g. Yale Univ.
1096,357	Ganado, Apache Co.	Si	1	38.9g.	Fd. 1938	
1109,337	Gun Creek, Gila Co.	Om	1	22.7kg.	Fd. 1909 Nov. 2	17.4kg. Harvard Univ.; 1kg. U.S. Nat. Mus.
1100,349	Holbrook, Navajo Co.	Cck	15,000	:218.6kg.	Fl. 1912 July 19, 7:15 P.M.	11kg. Chgo. Nat. Hist. Mus.; 3½kg. U.S. Nat. Mus.; *&c.*
1091,352	Houck, Apache Co.	Og	1	66.3kg.	Fd. 1927	Chgo. Nat. Hist. Mus.
[1116,353	Mount Elden, Coconino Co.: prob. = Canyon Diablo	Si	1	3.9kg.	Unkn.	190g. U.S. Nat. Mus.]
1098,365	Navajo, Apache Co.	D_2	2	2188.5kg.	Fd. 1922	Chgo. Nat. Hist. Mus.
1117,352:*	San Francisco Mountains, nr. Flagstaff, Coconino Co.	Off	1	1700g.	Fd. *c.* 1920	1445g. U.S. Nat. Mus.
1109,322	Tucson, Pima Co.	D_2T	2	975kg.	Fd. *c.* 1850	U.S. Nat. Mus.
1137,354:	Wallapai Indian Res., Mohave Co.	Of	2	424kg.	Fd. 1927	306kg. U.S. Nat. Mus.; other ms., Univ. Ariz.
1126,340	Weaver Mountains, Wickenburg, Maricopa Co.	D_1B	1	38.9kg.	Fd. 1898	Univ. Ariz.
1128,340A	Wickenburg (1), Maricopa Co.	A	1	9.2kg.	Recg. 1940	Am. Mi. Mus.
1128,340B	Wickenburg (2), Maricopa Co.	Si	1	250g.	Recg. 1940	
1114,352	Winona, Coconino Co.	Msg	1	24kg.	Fd. 1928	Main ms., A. J. Townsend, Winona; 4½kg. Mus. N. Ariz.; 1kg. Ariz. Bur. Mines

NOTE TO ARIZONA

†Exclusive of Mount Elden, which is probably identical with Canyon Diablo.

CALIFORNIA: 13 FALLS

†Exclusive of Mount Elden, which is probably identical with Canyon Diablo.

California: 13 Falls

C.N.	Name	Cl.	No. Ms.	Tl. Wt.	Tm. Fl. or Fd.	Dep.
1231,409	Canyon City, Trinity Co.	Om	1	8.6kg.	Fd. 1875	4½kg. Chgo. Nat. Hist. Mus.
1205,420	Goose Lake, Modoc Co.	Om-Og	1	1,167kg.	Fd. 1938 Oct. 13	U.S. Nat. Mus.
1156,329:	Imperial, Imperial Co.	C	1	Unkn.	Kn. 1908	4g. U.S. Nat. Mus.
1153,354	Ivanpah, San Bernardino Co.	Om	1	58.2kg.	Fd. 1880	Calif. State Mining Bur.
1178,349A	Muroc, Kern Co.: poss. = Muroc Dry Lake	C	1	18.4g.	Fd. 1936 Sep. 20	Griffith Obs., Los Angeles
1178,349B	Muroc Dry Lake, Kern Co.: poss. = Muroc	Ca	2	223g.	Fd. 1936 Sep. 20	Griffith Obs., Los Angeles
1216,395	Oroville, Butte Co.	Om	1	24kg.	Fd. 1893	Calif. Acad. Sci., San Francisco
1180,374	Owens Valley, Inyo Co.	Om	1	193.2kg.	Fd. 1913	U.S. Nat. Mus.
1181,349	Rosamond Dry Lake, Kern Co.	C	1	850g.	Fd. 1940 Nov. 24	Pomona Coll., Claremont, Calif.
1160,350:	San Emigdio Mountains, San Bernardino Co.	Cc	1	36.4kg.	Fd. 1887	527g. U.S. Nat. Mus.
1209,386	Shingle Springs, El Dorado Co.	D_1Sh	1	38.6kg.	Fd. 1869-70	932g. Yale Univ.
1159,342	Surprise Springs, Bagdad, San Bernardino Co.	Om	1	1.5kg.	Fd. 1899	1kg. Chgo. Nat. Hist. Mus.
1157,355	Valley Wells, San Bernardino Co.	Cg	4	130g.	Fd. 1929 June 10	Am. Mus. Nat. Hist.

Colorado: 41 Falls

C.N.	Name	Cl.	No. Ms.	Tl. Wt.	Tm. Fl. or Fd.	Dep.
1038,400	Adams Co.	Cb	1	5.7kg.	Fd. 1928	Colo. School Mines; Am. Mi. Mus.; 310g. U.S. Nat. Mus.; 250g. Chgo. Nat. Hist. Mus.
1032,402	Akron, Washington Co.	A	1	4-7kg.	Fd. 1940	
1057,375	Alamosa, Alamosa Co.	A	1	1.8kg.	Fd. 1937	
1032,397	Arickaree, Washington Co.	D_1-D_3	1	5.7kg.	Fd. 1927	
1033,393A	Arriba (1), Lincoln Co.	C	4	30.6kg.	Fd. 1936 and later	Colo. Mus. Nat. Hist.; 962g. U.S. Nat. Mus.
1033,393B	Arriba (2), Lincoln Co.	A	1	0.5kg.	Fd. 1937	
1053,396	Bear Creek, Jefferson Co.	Of	1	227kg.	Fd. 1866	Amherst Coll.

COLORADO (CONTD.)

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1090,380	Bishop Canyon, San Miguel Co.	Of	1	8.6kg.	Fd. 1912	Chgo. Nat. Hist. Mus.
1028,397	Cope, Washington Co.	A	11	12kg.	Fd. 1934	5.1kg. U.S. Nat. Mus.; 6.8kg. Am. Mi. Mus.
1066,385	Doyleville, Gunnison Co.	A	1	112g.	Fd. 1887	Am. Mi. Mus.; U.S. Nat. Mus.
1047,405	Eaton, Weld Co.	Mi?: copper-zinc-lead	1	29.5g.	Fl. 1931 May	Am. Mi. Mus.
1028,407	Fleming, Logan Co.	A	1	1.75kg.	Fd. 1940	
1046,388	Franceville, El Paso Co.	Om	1	18.8kg.	Fd. 1890	
1055,388	Guffey, Park Co.	D	1	310kg.	Fd. 1907 Nov.	Am. Mus. Nat. Hist.
1021,380	Holly, Prowers Co.	A	2	299g.	Fd. 1937	37½g. U.S. Nat. Mus.
1023,406A	Holyoke, Phillips Co.	A	1	5.5kg.	Fd. 1933	
1025,375:	Horse Creek, Baca Co.	Si	1	570g.	Fd. 1937	U.S. Nat. Mus.
1035,391	Hugo, Lincoln Co.	A	1	80g.	Fd. 1936	
1049,403	Johnstown, Weld Co.	Chl	27-30	40.3kg.	Fl. 1924 July 6, 4:20 P.M.	Largest stone, Am. Mus. Nat. Hist.; 860g. U.S. Nat. Mus.
1036,387	Karval, Lincoln Co.	A	1	1104g.	Fd. 1936	U.S. Nat. Mus.
1031,405	Kelly, Logan Co.	Cwb-Cgb	1	44.3kg.	Fd. 1937	405g. U.S. Nat. Mus.
1051,400	Lafayette, Boulder Co.	Si:D_1?	1	11g.	Fd. *c.* 1908	
1034,392:*	Lincoln Co.	A	1	498g.	Fd. 1937	71g. U.S. Nat. Mus.
1058,375:A*	Lost Lake, Alamosa Co.	A	1	11g.	Fd. *c.* 1931	
1085,372	Mesa Verde Park, Montezuma Co.	Om	1	3.5kg.	Fd. 1922	U.S. Nat. Mus.
1063,386	Mount Ouray, Chaffee Co.: C.N. for Ouray Pk.	Om	1	0.9kg.	Fd. 1898	Harvard Univ.
1058,375:B*	Newsom, Alamosa Co.	A	1	892g.	Fd. 1939	
1023,410	Ovid, Sedgwick Co.	A	1	6.17kg.	Fd. 1939	
1031,410	Peetz, Logan Co.	Cs	1	11.5kg.	Fd. 1937	Am. Mi. Mus.; 812g. U.S. Nat. Mus.
1023,406:B*	Phillips Co.	P	1	1.3kg.	Fd. 1935	250g. U.S. Nat. Mus.
1028,385:*	Rush Creek, Kiowa Co.	A	3	9.3kg.	Fd. 1938	Am. Mi. Mus.
1055,398	Russel Gulch, Gilpin Co.	Of	1	13.2kg.	Fd. 1863	5.2kg. Am. Mus. Nat. Hist.; 1.75kg. Harvard Univ.
1029,393	Seibert, Kit Carson Co.	A	1	3.5kg.	Fd. 1941	

1029,393	Seibert, Kit Carson Co.	A	1	3.5kg.	Fd. 1941	Harvard Univ.

COLORADO (CONTD.)

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1034,395	Shaw, Lincoln Co.	Am	2	3.7kg.	Fd. 1937	1.7kg. U.S. Nat. Mus.
1026,374	Springfield, Baca Co.	A	2	283g.	Fd. 1937	
1032,406	Sterling, Logan Co.	P	1	679.5g.	Fd. *c.* 1900	
1027,373	Stonington, Baca Co.	Cka	1	2.75kg.	Unkn.; rep. 1942 Feb.	
1062,398	Ute Pass, Summit Co.	Ogg	1	120g.	Fd. 1894	Chgo. Nat. Hist. Mus.
1039,403	Weldona, Morgan Co.	A	1	22.7kg.	Fd. 1934	1kg. U.S. Nat. Mus.
1027,382	Wiley, Prowers Co.	Si	1	3.5kg.	Fd. 1938	179g. U.S. Nat. Mus.
1022,400	Wray, Yuma Co.	A	1	281.7g.	Fd. 1936	

IDAHO: 3 FALLS

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1138,450	Hayden Creek, Lemhi Co.	Om	1	270g.	Fd. 1895	
1139,422	Oakley, Cassia Co.	Og	1	111kg.	Fd. 1926	
1170,438	Parma Canyon, Ada Co.	Si	1	2.15kg.	Fd. 1940 Apr. 2	Brown Foundation, Walla Walla, Wash.

MONTANA: 1 FALL

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1130,461:*	Illinois Gulch, Deer Lodge Co.	D_1C	1	2.5kg.	Fd. 1899	602g. Chgo. Nat. Hist. Mus.

NEVADA: 4 FALLS

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1150,365:	Las Vegas, Clark Co.	Si	1	Or. wt. unkn.	Fd. 1930	3kg. U.S. Nat. Mus.
1167,372	Quartz Mountain, Nye Co.	Og	1	4.8kg.	Fd. 1935	Mackay Mus., Univ. Nev.
1154,381	Quinn Canyon, Nye Co.	Om-Og	1	1,450kg.	Fd. 1908	Chgo. Nat. Hist. Mus.
1172,380:	Tonopah, Nye Co.	O	Sev.	Unkn.	Unkn.	33g. U.S. Nat. Mus.

New Mexico: 31 Falls

C.N.	Name	Cl.	No. Ms.	Tl. Wt.	Tm. Fl. or Fd.	Dep.
1057,326	Alamogordo, Otera Co.	A	Num.	13.6kg.	Fd. 1938	
1050,363	Aurora, Colfax Co.	A	1	1kg.	Fd. 1938	
1080,364	Aztec, San Juan Co.	A	1	2.8kg.	Fl. 1938 Feb. 1, 5:00 P.M.	
1037,364	Beenham, Union Co.	Cga	Num.	44.4kg.	Fd. 1937	4kg. U.S. Nat. Mus.
1083,353	Breece, McKinley Co.	Om	1	50kg.	Fd. 1921	Chgo. Nat. Hist. Mus.
1055,369	Costilla Peak, Taos Co.	Om	1	35.4kg.	Fd. 1881	9½kg. Chgo. Nat. Hist. Mus.; 3½kg. Am. Mus. Nat. Hist.; 1½kg. Vienna Naturhist. Mus.
1053,337	El Capitan Range, Lincoln Co.	Om	1	27.7kg.	Fd. 1893	9kg. Am. Mus. Nat. Hist.; 5kg. U.S. Nat. Mus.; 2½kg. Chgo. Nat. Hist. Mus.
1042,363	Farley, Colfax Co.	Cga	2	19.4kg.	Fd. 1936	U.S. Nat. Mus.
1089,368	Four Corners, San Juan Co.	ObC	1	25kg.	Fd. *c.* 1924	U.S. Nat. Mus.; 1½kg. Harvard Univ.
1040,363	Gladstone, Union-Colfax Co.	Cs	3	57.3kg.	Fd. 1936	U.S. Nat. Mus.
1058,356	Glorieta Mountain, Canoncito, Santa Fe Co.	Om	Sev.	145.4kg.	Fd. 1884	60¾kg. Vienna Naturhist. Mus.; 25kg. Am. Mus. Nat. Hist.
1033,348A	Grady (1), Curry Co.	A	1	4234g.	Fd. 1933	
1033,348B	Grady (2), Curry Co.	A	1	9.3kg.	Fd. 1937	Am. Mi. Mus.
1079,345:	Grant, Zuni Mtns., Valencia Co.	Of-Om	1	481.8kg.	Fd. 1929	U.S. Nat. Mus.
1031,327	Hobbs, Lea Co.: C.N. for "New Hobbs"	A	1	2.3kg.	Fd. 1921	1.1kg. Am. Mi. Mus.; 30g. U.S. Nat. Mus.; Chgo. Nat. Hist. Mus.
1077,329	Kingston, Sierra Co.	Om	1	12.9kg.	Fd. 1891	
1041,334	LaLande, De Baca Co.	A	1	35kg.	Unkn.	
1070,340	Luis Lopez, Socorro Co.	Om	1	7kg.	Fd. 1896	3kg. Chgo. Nat. Hist. Mus.
1036,344	Melrose, Curry Co.	C	6	59.5kg.	Fd. bef. 1933	Am. Mi. Mus.; 990g. U.S. Nat. Mus.; 608g. Am. Mus. Nat. Hist.
1066,338	Oscuro Mountains, Socorro Co.	Og	3	3.7kg.	Fd. 1895	577g. Chgo. Nat. Hist. Mus.
1038,362	Pasamonte Ranch, Union Co.	Ho	75-80	4kg.	Fl. 1933 Mar. 24, 5:05 A.M.	Chgo. Nat. Hist. Mus.; 68g. U.S. Nat. Mus.; Am. Mi. Mus.; *&c.*

5:05 A.M.

NEW MEXICO (CONTD.)

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1051,327	Pinon, Otero-Chaves Co.	D_1	1	17.85kg.	Fd. 1928 or 1930	14kg. U.S. Nat. Mus.; 7kg. Am. Mi. Mus.
1059,357:*	Pojoaque, Santa Fe, Santa Fe Co.: poss. = Glorieta Mtn.	PR	1	128g.	Fd. 1930	Lab. of Anthropology, Santa Fe; 10g. Am. Mi. Mus.
1068,344	Puente-Ladron, Socorro Co.	A	1	7.7g.	Fd. 1944 May 17	Am. Mi. Mus.
1040,359	Roy, Harding Co.	Ck	1†	50kg.	Fd. 1933, spring	Am. Mi. Mus.; Chgo. Nat. Hist. Mus.
1047,329	Sacramento Mountains, Eddy Co.	Om	1	237.7kg.	Fd. 1896	8.4kg. Chgo. Nat. Hist. Mus.; 4.4kg. U.S. Nat. Mus.
1067,350:*	Sandia Mountains, nr. Albuquerque, Bernalillo Co.	H	1	15kg.	Fd. *c.* 1915	10kg. Am. Mi. Mus.; 1.2kg. U.S. Nat. Mus; Chgo. Nat. Hist. Mus.
1057,357	Santa Fe, Santa Fe Co.: poss. = Glorieta Mtn.	Of	1	11.5kg.	Fd. 1930 Oct.; kn. bef. 1930	U.S. Nat. Mus.
1033,332	Tatum, Lea Co.	A	1	1.8kg.	Fd. 1938	
1039,358:*	Tequezyuito Creek, Harding Co.	A	1	5.45kg.	Fd. 1934	
1039,362:	Ute Creek, Union Co.	A	Sev.	2kg.	Fd. 1936	U.S. Nat. Mus.

NOTE TO ROY, NEW MEXICO

†According to Hey, a second stone (wt. 5273g.) was found before 1939, but that it belongs to this fall (Roy) is not certain.

OREGON: 3 FALLS

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1245,428	Port Orford, Rogue River Mountains, Curry Co.	PK	1	10,000:kg.	Fd. 1859	4g. Vienna Naturhist. Mus.
1230,424	Sams Valley, nr. Medford, Jackson Co.	Om	1	6.9kg.	Fd. 1894	
1226,454	Willamette, Clackamas Co.	Om	1	14,175:kg.	Fd. 1902	Am. Mus. Nat. Hist.

UTAH: 6 FALLS

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1102,404	Altonah, Duchesne Co.: poss. = Duchesne Co.	Si	1	21.5kg.	Fd. 1932	10.5kg. U.S. Nat. Mus.; 10.2kg. Am. Mi. Mus.
1123,390	Drum Mountains, Millard Co.	Si	1	52.9kg.	Fd. 1944 Dec. 22	U.S. Nat. Mus.
1104,402	Duchesne, Duchesne Co.	Of	1	22.8kg.	Fd. *c.* 1906-7	245g. Am. Mus. Nat. Hist.; Am. Mi. Mus.
1108,404	Mount Tabby, Hanna, Duchesne Co.: prob. = Duchesne	O	1	24.5kg.	Fd. *c.* 1921	886g. Am. Mus. Nat. Hist.
1121,390	Salina, Sevier Co.	Om	1	235g.	Fd. 1908	U.S. Nat. Mus.
1116,408	Salt Lake City, Salt Lake Co.	Cgb	1	0.9kg.	Fd. 1869	834g. Yale Univ.

WASHINGTON: 2 FALLS

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1224,456:	Washougal, Clark Co.	Ho	1	220g.	Fl. 1939 July 2, 7:58 A.M.	J. H. Pruett's colln., Eugene, Ore.
1203,477:	Waterville, Douglas Co.	Si	1	34kg.	Fd. bef. 1929	

WYOMING: 9 FALLS

C.N.	NAME	CL.	NO. MS.	TL. WT.	TM. FL. OR FD.	DEP.
1041,415	Albin, Laramie Co.	P	1	37.6kg.	Fd. 1915; recg. 1935	Am. Mi. Mus.; 3170g. U.S. Nat. Mus.
1042,445	Bear Lodge, Crook Co.	O	1	48.6kg.	Fd. 1931, summer	S. Dak. School Mines; 3.1kg. U.S. Nat. Mus.
1047,437	Clareton, Weston Co.	Cg	1	1050g.	Fd. 1935	Am. Mi. Mus.; 147g. U.S. Nat. Mus.
1044,429	Hat Creek, Niobrara Co.	A	1	8.9kg.	Fd. 1939	
1043,418	Hawk Springs, Goshen Co.	Cg-Cs	3	367g.	Fd. 1935 Dec. 23	Am. Mi. Mus.; U.S. Nat. Mus.
1045,428	Lusk, Niobrara Co.	Six	1	Undet.	Fd. 1940	
1041,412	Pine Bluffs, Laramie Co.	A	1	2.7kg.	Fd. 1935	
1053,412	Silver Crown, Laramie Co.	Og	1	11.6kg.	Fd. 1887	6.9kg. Vienna Naturhist. Mus.
1063,429:*	Willow Creek, Natrona Co.	Om	1	51.2kg.	Fd. *c.* 1814; recg. 1934	Am. Mi. Mus.; 5.3kg. U. S. Nat. Mus.

President of the Society: ARTHUR S. KING, Mount Wilson Observatory, Pasadena 4, California
Secretary of the Society: OSCAR E. MONNIG, 1010 Morningside Drive, Fort Worth 3, Texas

Meteors Discovered by Radar

The British Astronomical Association Circular, No. 282, bearing the date 1947 June 26, reports the discovery of a new meteor shower by Dr. A. C. B. Lovell, who is directing the radar research on meteors at the Manchester University, as follows:

Scientists at the Jodrell Bank Experimental station of the University of Manchester have recently discovered a major meteor shower occurring in daylight. Over the past year they have used the technique of radio reflection to study the ionisation caused by meteors in the upper atmosphere. An aerial system producing a beam of radiation about ±6° wide and capable of being directed to any point in space, has enabled particular meteor radiants to be selected and studied in detail. In addition, by a method devised by J. A. Clegg (not yet published) it is possible to determine the radiant points of meteor streams. Throughout the autumn and winter the well-known showers have been investigated by this method and apart from minor variations the general predictions made by J. P. M. Prentice from previous visual observations have been found to be accurate.

In the investigation of the η Aquarid radiant which began on May 1, 1947, it was immediately obvious that the meteor stream visible to the astronomers was merely the beginning of an extremely active belt stretching towards the Sun. The main radiant point of this stream was found to lie in Pisces. Transit occurred at about 1000 to 1100 U.T. and hence no knowledge of the shower can have been obtained by visual observation.

The Aquarius end of this belt disappeared in mid-May as expected, but the Piscid radiant continued with undiminished and extraordinary intensity. At the time of writing (June 22) the shower has continued for 53 days, is still active, and shows no sign of ending. It will be some time before the mass of data accumulated can be analysed but it is apparent that this shower is unique in extent and duration. The main knot has fluctuated in intensity but the hourly rate at transit has never fallen below 20 and has often exceeded 80. The surprising nature of this event will be realized when it is pointed out that a shower such as the Geminids in December, 1946, produced an hourly rate of only 12, 25, 25, 43, 20, 7 over successive nights on this apparatus.

Preliminary analysis gives the approximate positions of the new radiant as follows:

May	7	R.A. 20°	N.Dec. 20 to 25°
June	22	70°	20 to 25°

In addition minor radiants have appeared occasionally for a few days at about 15°W. and 10°E. of the main knot at the same declination, and on some occasions the whole area between these extremes has been active.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

The Hood College AAVSO Spring Meeting: In spite of overcast skies for much of the time, with showers interspersed, especially at night, the 1947 Spring

President of the Society: Arthur S. King, Mount Wilson Observatory, Pasadena 4, California
Secretary of the Society: Oscar E. Monnig, 1010 Morningside Drive, Fort Worth 3, Texas

Meeting, held for the second time in fifteen years at Hood College, on May 16 and 17, proved to be an enjoyable and profitable occasion for some 40 of our members and their guests.

By the afternoon of the 16th some of the members began to gather, and by evening a considerable number had arrived. There were Buckstaff from Oshkosh, Wisconsin, Seely from New York City, the Boothroyds from Ithaca, who brought along Miss Martha Stahr, now an astronomer on the staff of Cornell University, Mr. and Mrs. Treadwell of Arlington, New Jersey, Mr. and Mrs. Heines, with a guest, from Paterson, New Jersey, and 1st Vice President Marjorie Williams of Smith College. Connecticut was represented by Mrs. Hamilton and son Richard, and Mr. Martin; Pennsylvania by Miss Lois Slocum and one of her students, and Messrs. Rumrill and Mullen, the latter a new member from Pennsylvania State College. Mr. and Mrs. James C. Bartlett came from nearby Baltimore. From Washington, D. C., there arrived on Saturday morning the Morgan Cilleys and Carroll Slemaker. Mr. Hiett and his mother, from Martinsburg, West Virginia, were also in evidence, together with a group from Aberdeen, Maryland—Dr. and Mrs. Karpov, who brought along Miss Hoffleit. There were others present from Frederick and nearby points, north, east, south, and west.

The Council meeting got under way with the arrival of the Recorder, who carried with him the reports and other documents essential to the conduct of the business at hand. In the absence of President Smiley, who at that moment was in Brazil, anxiously awaiting the opportunity to observe the total eclipse of the sun scheduled for the 20th, first Vice President Williams ably presided at the several sessions.

Due to the absence of the Secretary, Miss Stahr obligingly took on the task of secretary pro-tem, and Mr. Roy Seely agreed to act as writer-up of the meeting for Variable Comments.

It was announced that the AAVSO had, by an overwhelming majority of votes sent in by over 100 members, decided to join the Amateur Astronomers League. The Council also approved the recommendations of the Chart Committee that the prices of charts be revised to meet the increased cost of production. Henceforth prices on charts will be as follows:

Item	Cost to members	Cost to non-members
8" x 10" charts	8c, or 2 for 15c	10c
Atlases (unbound)	$1.75	$2.00
Finder charts	5c	5c
Complete set of charts (700 or more)	$50.00	$75.00

Mr. D. F. Brocchi, Chairman of our Chart Committee, was elected a Patron of the Association in recognition of his generosity, especially in presenting recently to the AAVSO the tube and optical parts of his excellent home-made reflector. We are pleased to add the statement that, although Mr. Brocchi is at present still confined to a hospital, his health is somewhat improved over what it was a year or more ago.

The deaths, since our last meeting, of four members were announced with regret: Messrs. William L. Holt, H. H. Clayton, William B. Stearns, and Knox Lee.

The Council elected Mr. Cyrus F. Fernald, our present-day ace observer, to fill the unexpired term of the late Dr. Holt. Also, it approved the slate of

nominees for Council for 1947-49, as presented by the Nominating Committee. The slate, to be voted upon at the Fall meeting, consists of four names for the four places:

Ralph N. Buckstaff, Oshkosh, Wisconsin, Cyrus F. Fernald, Wilton, Maine, Clinton B. Ford, Windsor Locks, Connecticut, and Peter M. Millman, Ottawa, Canada.

Fourteen individuals were elected to annual membership:

David Alder, Ogden, Utah
Ralph S. Bates, Cambridge, Mass.
Elmer R. Canfield, Rapid City, S. D.
Paul W. Davis, Rochester, New York
Owen Gingerich, North Newton, Kansas
James R. Hillebrand, Detroit, Michigan
Daniel James, Anaheim, California
Gilbert Matthews, Andover, Mass.
William Miller, Glen Rock, New Jersey
Willard F. Mullen, State College, Penna.
Robert E. Pearcy, Indianapolis, Indiana
Carroll Slemaker, Washington, D. C.
William G. Tifft, Frederick, Maryland
James L. Weber, San Antonio, Texas

Following the Council session, Professor Allen and her assistant served a very welcome repast, not only to those who had been busy at the Council meeting, but to those others who had arrived and had been shown about the well-equipped observatory—which boasts a fine 8-inch refractor—and had enjoyed the opportunity of getting better acquainted with one another.

The Saturday morning session started at 10:20 o'clock, with some routine matters being reported upon, including the comprehensive report of the Solar Division by Mr. Heines, its chairman and director. Membership of the division numbers eighty-eight, forty-three being counted as active observers, with distribution in 21 states of the U.S.A. and seven foreign countries. The number of observations reported for the year was 4688; the total to date is 16,628. Seven issues of the Bulletin of the Solar Division have been published. Mr. Heines reported that we are apparently near the time of maximum of the present sunspot cycle, and that it will have a high sunspot-number value—the highest in many years. Reference was also made to the Granulation project, and the Migratory Bird observation program. Solar data were supplied to 21 individuals and institutions.

An extensive program of papers was presented:

Types of Solar Granulation, by James C. Bartlett, Jr.

The Sun, A "Microwave" Variable, by Martha E. Stahr

100 Years of R Coronae Borealis, by Leon Campbell

Light Absorption in Colored Glass, H. B. Rumrill

Variable Star Observing "Down Under," Frank M. Bateson

Climate in Upper Midwestern U. S. and its Relation to Sunspots, Franklin J. Ryder

Life Among Sunspots, W. G. Bowerman

Sunspots and Radio Waves, H. T. Stetson

An Apparent Earth Effect upon Sunspot Activity, H. W. Clough

The program for the entertainment of the members had been well planned by our hostess, Miss Allen, and included a formal luncheon, served in southern style in Coblentz Hall at the College. Following the luncheon, Dr. Henry I. Stahr—President of the College and father of our Martha Stahr—greeted the

members and gave a brief history of the college. At two o'clock we posed in front of the observatory for a group photograph.

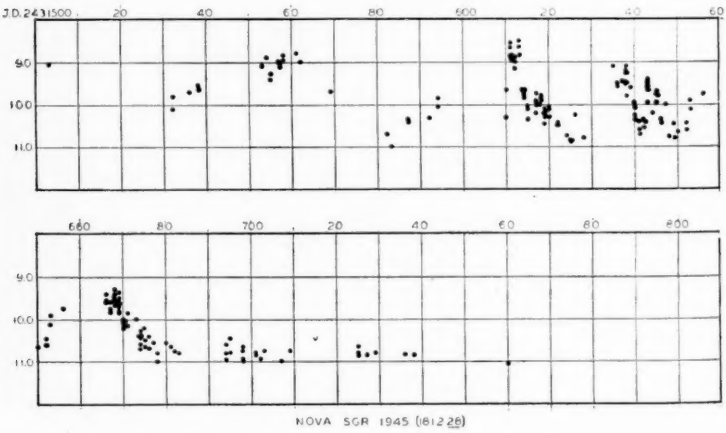
After formal adjournment of the afternoon meeting, the members and their guests were entertained at tea in the delightful atmosphere of the President's home by Dr. and Mrs. Stahr and a corps of charming ladies, former and present students in astronomy. The whole affair ended up with an informal dinner in Coblentz Hall, after which those members who had not departed earlier dispersed to their respective hotels, preparatory to leaving town the next morning.

One noticeable feature of the meeting was the presence of many members whose faces we do not usually see at our gatherings.

The 1947 Hood College meeting certainly equalled that of 1932 held at the same place, and another meeting there in the not too distant future would be most welcome.

The Fall meeting of the Association will be held, as usual, at Harvard on October 10 and 11 next.

Nova Sagittarii, 1945: The region of Sagittarius still proves to be a fruitful field in which to search for novae, new or old. Mrs. Mayall, in examining plates taken at the Harvard Station in South Africa, has detected, from the appearance of its spectrum, another nova which appeared in 1945. The nova was not seen on chart plates taken in August and September, 1944—fainter than 16.5—nor on October 5, 1944. It was first seen on a plate of February 16, 1945, at 9th magnitude. The star went through a series of irregularities in brightness throughout the observing season of 1945, varying, with sharp rises from minimum to maximum, between magnitudes 8.5 and 11.0. Scattered observations from March to June, 1946, also show an irregular variation between magnitudes 11 and 12. The accompanying figure shows the variations from February through October, 1945.



Current AAVSO Variables: Gamma Cassiopeiae, 005060, appears to be slightly brighter than it was last January; its mean magnitude is now 2.7 instead of 2.9.

Mira, o Ceti, 021403, reached maximum on December 5, 1946, mean magnitude 4.2. The next maximum is due on November 1, 1947, and the star should be well observed from August on, when it should begin again to increase in brightness.

R Horologii, 025050, a southern long-period variable of large range—over eight magnitudes—whose light curve somewhat resembles that of Chi Cygni, was at maximum in November, 1946, and is due to reach that same phase again next December.

RR Tauri, 053326, continues to act in a very irregular manner, somewhat as does V Sagittae (see these Notes, POPULAR ASTRONOMY, March, 1937).

SU Tauri, 054319, is at maximum brightness, around magnitude 9.7.

Alpha Orionis, 054907, has, during the past 300 days, varied between mean magnitudes 0.6 and 1.1, with a maximum indicated around January, 1947. In spite of its red color and the difficulty of observing it, the star should be followed diligently, especially by observers with no instrumental equipment. Caution must be taken, though, that comparisons with other stars should be made only when variable and comparison stars are at nearly equal altitudes.

SS Aurigae, 060547, passed through a broad maximum about February 3, and a narrow maximum on April 8, 1947.

Nova (RR) Pictoris, 063462, rather assiduously followed by Mr. de Kock of Capetown, appears to hover around magnitude 10.8, with little, if any, change in brightness.

U Geminorum, 074922, was well observed during its recent broad maximum, late in May. An interval of 150 days elapsed between this maximum and the previous narrow-type maximum observed last December.

Nova Puppis, (1942), 080835, like Nova Pictoris, is rather constant in light, at magnitude 10.8.

Z Camelopardalis, 081473, has had five well-observed maxima since December, 1946, in a mean cycle of 31 days, a value somewhat larger than usual.

R Leonis, 094211, attained a maximum magnitude of 5.0 early in June.

Delta Ursae Majoris, 121257, appears to have increased in brightness from magnitude 4.1 in September, 1946, to 3.4 in May of this year. The star should be carefully watched to note if the suspected variation is confirmed.

R Hydrae, 132422, attained a maximum magnitude of 4.8, late in April, which indicates a continued shortening of its period; 380 days between the last two observed maxima.

S Apodis, 145971, was observed by Itzigsohn of La Plata Observatory, as fainter than magnitude 15 between February 18 and March 19, 1947, a decrease of at least five magnitudes from normal maximum brightness.

R Coronae Borealis, 154428, is now definitely at normal maximum brightness, magnitude 6.0.

Nova (RS) Ophiuchi, 174406, rose to a maximum magnitude of 11.0 in May, about 500 days following a similar increase in brightness.

R Scuti, 184205, has undergone six decreases to minimum since July, 1946, an

average cycle of 66 days, as against a mean value of 70.9-day period as deduced from observations made over the past one hundred years, or 141.8 days, if we consider this period as doubled. The period has been far from regular over this space of time; a plot of the data shows somewhat abrupt deviations from uniformity.

RY Sagittarii, 191033, was still at minimum brightness, fainter than 13.0 late in April, and fainter than 11.5 late in May. This star, like S Apodis, should be carefully watched in the coming months, in order to catch it on the increase to maximum.

Chi Cygni, 194632, increased steadily from a minimum magnitude of 13.4 late in December, 1946, to magnitude 5.4 early in June, 1947, a total range of at least eight magnitudes.

V Sagittae, 201520, with many of the attributes of an old nova, has behaved very erratically during the past year, varying between magnitudes 12.6 and 11.2.

SS Cygni, 213843, has, since December, 1946, been observed at three maxima, one in February of wide type, a second late in March of the anomalous type, and a third at the end of April, evidently of the rapid-rising narrow type. Another maximum should make its appearance early in July.

Z Andromedae, 232848, rose from magnitude 10.2 in July, 1946, to magnitude 9.0 in January, 1947. The star showed indications of again decreasing in light at the end of June.

Rho Cassiopeiae, 234956, increased from magnitude 6.0 in November, 1946, to magnitude 4.8 in June, 1947.

Observations received during May and June: A total of 7121 observations—2628 in May and 4493 in June—were contributed by 78 observers, as follows:

Observer	May—1947—June				Observer	May—1947—June			
	No. Var.	No. Ests.	No. Var.	No. Ests.		No. Var.	No. Ests.	No. Var.	No. Ests.
Adamopoulos	..	..	9	13	Estremadoyro	..	..	1	7
Ahnert, P.	40	190	42	430	Fernald	199	331	204	414
Albrecht	..	..	9	9	Focas	..	..	80	311
Alder	..	..	4	4	Ford	24	24	7	27
Ball	..	..	28	54	Garneau	28	28	26	26
Bappu, M. K.	30	66	..	..	Gingerich	..	..	9	22
Bicknell	14	44	11	49	Greenley	9	15	18	40
Blunck	8	9	17	18	Halbach	..	..	19	19
Bogard	21	41	24	57	Hare	..	..	10	11
Boone	5	5	27	27	Harris	11	12	3	3
Brennan	3	3	2	2	Hartmann	106	108	112	112
Buckstaff	10	12	17	32	Hiett	..	..	7	11
Canfield	..	..	3	8	Howarth	19	19	19	19
Caraioryis	8	18	7	13	Hukill	3	15	3	22
Chandra	105	137	39	53	Itzigsohn	..	..	58	213
Chassapis	..	..	150	458	Kelly	10	11	10	10
Cilley	28	100	26	50	Kilby	..	..	7	8
Dafter	9	22	6	21	Kitley	45	78	50	62
Daley	1	1	2	4	Knott	3	4	28	54
Damkoehler	5	5	..	..	de Kock	85	428	96	422
Darnell	2	5	3	6	Koenitzer	..	..	2	2
Elias	..	..	70	240	Krumm	11	49	11	33
Epstein	10	35	7	9	Liller	25	25	..	..
Escalante	12	15	..	..	Luft	4	11	2	10

Observer	May—1947—June No. Var.	No. Ests.	No. Var.	No. Ests.	Observer	May—1947—June No. Var.	No. Ests.	No. Var.	No. Ests.
Mary	9	14	..	..	Slemaker	25	46	15	17
Miller	4	7	4	10	Swaelen	3	7	5	6
Nadeau	..	..	85	98	Tarbell	..	..	6	18
Oravec	43	84	57	164	Taulman	..	..	8	8
Parks	25	25	20	20	Thomas	21	32	10	13
Pearcy	12	33	18	29	Topham	20	21	..	..
Peltier	93	144	111	176	Upjohn	..	..	8	11
Peters	1	1	1	1	Vener	..	..	1	1
Polesny	..	..	1	8	Webb	16	21	24	27
Raphael	13	36	..	..	Weber	38	38	50	50
Renner	..	..	50	110	Welker	16	16	18	26
Rosebrugh	18	102	27	143	Welles	10	28	8	32
Salanave	3	3	..	..	Whitmarsh	5	11	6	11
Schoenke	..	..	7	7	Zirin	56	56	..	..
Sherman	8	37	15	64					
Sill	..	..	27	28	78 totals		2628		4493

July 15, 1947.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

Musings of a Meteor Observer

The writer had just witnessed a fireball, plotted it and recorded its characteristics, one of which was that at its end it seemed to puff up, give a flash, and disappear. It was this observation that started a train of thought in the writer's mind during the rest of the night. Later these musings were recalled and formed the basis of interesting discussion with other meteor observers. The writer is willing to admit that the following discourse may be much ado about nothing yet he believes that there may be a shred of truth in the ideas and that they might be an anticipation of facts still to be discovered. By presenting the ideas as a conceptual possibility, the writer hopes that others will find stimulus for thought along new lines.

The observation mentioned was certainly an indication that the fireball exploded. One almost expected to hear a pop or sound of some kind. What the writer wishes to postulate is that a sonic disturbance is produced by every meteor. The fireball mentioned was of magnitude —2 or —3. The average height of disappearance of fireballs of this magnitude is thirty miles. Research on firing of big guns and other explosions has shown that sound waves may rise as high as thirty-five miles and be reflected down to earth again. Under favorable conditions and with the aid of detecting apparatus may it not be possible to detect faint direct sounds from meteors, especially from the brighter ones which in regular observing are not too rare? It is not beyond modern technique to construct such apparatus. For instance, to collect a sound, a concave sound mirror some thirty feet in diameter is a practical size. The latest advances provide amplifying

circuits of extreme sensitivity. The microphone used might be of the hot wire type, the most sensitive known. Since the sound would take minutes to reach the observer, there would be sufficient time to direct the sound mirror in the proper direction. Sound from meteors even higher up may be detected. The air pressure at a height of sixty miles is 0.2 mm. Though this is rather low for the propagation of sound in the ordinary sense, the writer can conceive that an object traveling at high speed would produce a powerful sonic disturbance perhaps even an entirely different type of sound. This might be a pulse or ball of air at high pressure which would continue to travel for some distance after the meteor itself had disappeared. This "hypersonic sound" would differ as much from the shock or supersonic sound wave as the shock wave does from the ordinary sound wave. Such an experiment in meteor sound detection might be especially practical during a shower, as for instance, at the next return of the Draconids.

A new field of research might be opened up, for surely faint sounds must originate in the high atmosphere due to meteorological and electrical causes. Also by equipping V2 rockets so that they release bombs to explode at various heights and trying to detect any sound resulting might be an experiment of interest. To digress a bit, a tremendous turmoil of sound must be produced in the solar atmosphere and photosphere. It is not possible that, under the terrific pressures and stresses, super-sound waves might arise, perhaps with capabilities and characteristics beyond the physics of ordinary sound? Some peculiar types of prominences look like nothing more than shock waves. Might there even be, for one thing, an influence on spectrum lines due to super-sound waves? The writer has thought that it may be possible to further modify the pulsation theory of some Cepheids by considering the variations to be due to super-shock waves arising from regenerative atomic explosions deep within the star. Such shock-waves coursing through the star would indicate only an apparent pulsation in diameter.

To discuss such ideas further would only cast doubt on the writer's seriousness in suggesting the ideas. They are better left for the time being as just musings.

VINCENT ANYZESKI.

400 Lombard St., New Haven 13, Connecticut.

General Notes

Dr. Henry Norris Russell, internationally recognized astronomer and very active in astronomical circles in this country for many years, was one of four members of the Princeton University faculty who retired from active duty at the close of the academic year in June. It is hoped that Dr. Russell will continue to grace the meetings of the American Astronomical Society with his presence for many years to come, since these meetings would surely suffer a marked decline without him.

American Astronomical Society Meetings

According to an announcement from the office of the Secretary, the next meeting of the Society will be held at Dearborn Observatory, Northwestern University, Evanston, Illinois, September 3-6, 1947. Plans have been made to house the members and guests in nearby dormitories and in Quonset Huts. In celebration of the fiftieth anniversary of the founding of the Society and of the Yerkes

Observatory, the concluding session is planned for Saturday, September 6, at the Yerkes Observatory, Williams Bay, Wisconsin.

The December meeting, which will be the seventy-eighth, will be held in Columbus, Ohio, December 28-31, 1947. A feature of this meeting will be the second Henry Norris Russell lecture by Dr. Walter S. Adams.

British Eclipse Expedition to Brazil ends in Disaster

After several months of preparation for the eclipse of May 20 by Dr. J. A. Carroll of Aberdeen, under the auspices of the Joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society, the major part of the equipment for the observations was dispatched by boat from England on March 11. The plan was to have the three observers, Dr. A. Hunter of the Royal Observatory, Greenwich, Dr. Alan Baxter, a member of Dr. Carroll's staff, and Mr. J. H. Strong, of the Imperial College of Science and Technology, follow by air a month later. In attempting a landing at Dakar in a fog, the plane, in which these three observers were traveling, crashed with the result that Dr. Baxter was killed instantly and Mr. Strong received injuries which later proved fatal. Dr. Hunter escaped with severe cuts and abrasions. It was thought that the program might be continued by other observers, but, when it was learned that the delicate instruments were for the most part completely destroyed in the accident, the expedition was abandoned.

A Directory of Astronomical Observatories in the United States has recently been compiled by Mabel Sterns, and published by J. W. Edwards, Ann Arbor, Michigan. It lists 300 amateur and professional observatories with names, addresses, and descriptions. Sections are arranged by name of observatory, and by state and city. The book contains more than 70 illustrations and a map 12 inches by 19 inches. Paper-bound, 5½ inches by 8½ inches lithoprinted, 162 pages. $2.85 each, available from the compiler at 2517 K Street N. W., Washington 7, D. C.

The Strolling Astronomer

A few months ago we received a complimentary copy of Volume I, Number 1 of a mimeographed edition under the above title. The purpose of the publication is to "coordinate the activities of amateur astronomers." The first issue contains a miscellany of items of interest to the group particularly addressed by it. It is planned as a monthly under the editorship of Walter H. Haas, and the counsellorship of Dr. Lincoln La Paz. Any who wish to receive these issues regularly should send one dollar for copies of six issues to

The Strolling Astronomer
Institute of Meteoritics
University of New Mexico
Albuquerque, N. M.

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